NOVEMBER 1970

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RAILWAY SYSTEM CONTROLS

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ACI: AAR sets interface standard

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MODEL CLS-10

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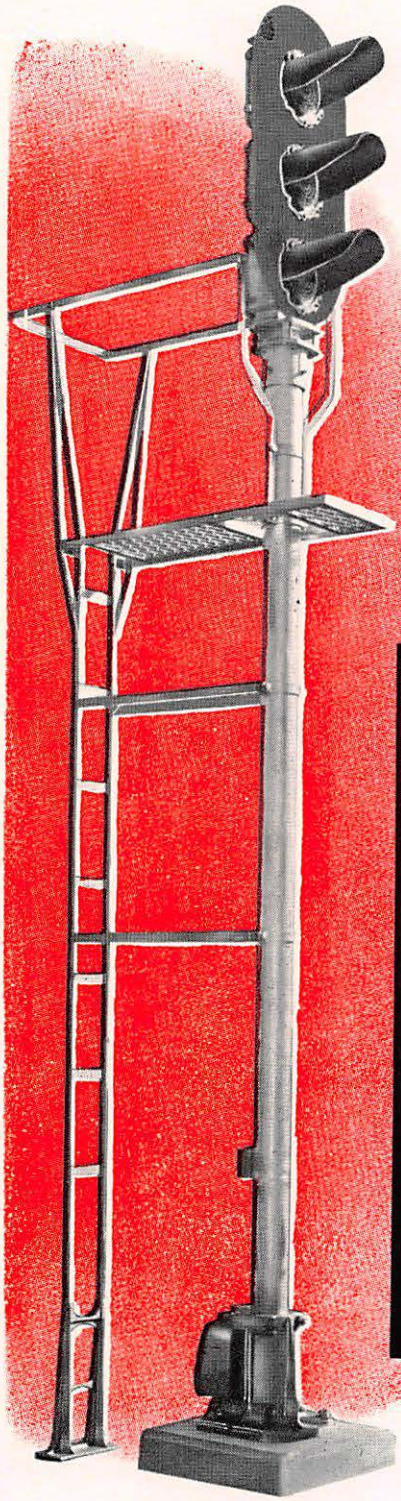

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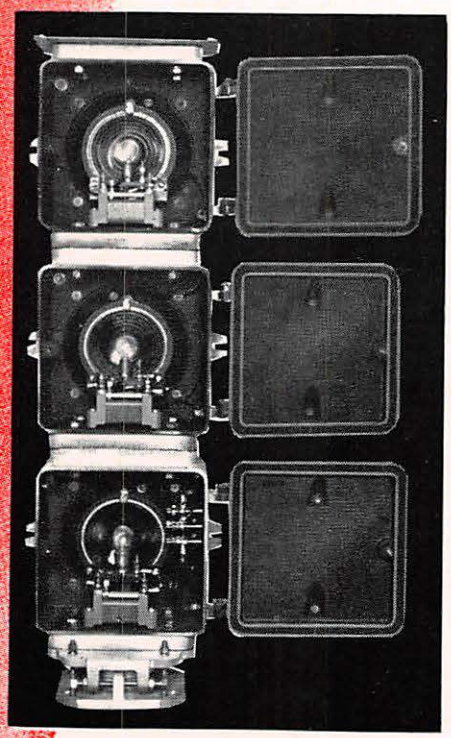

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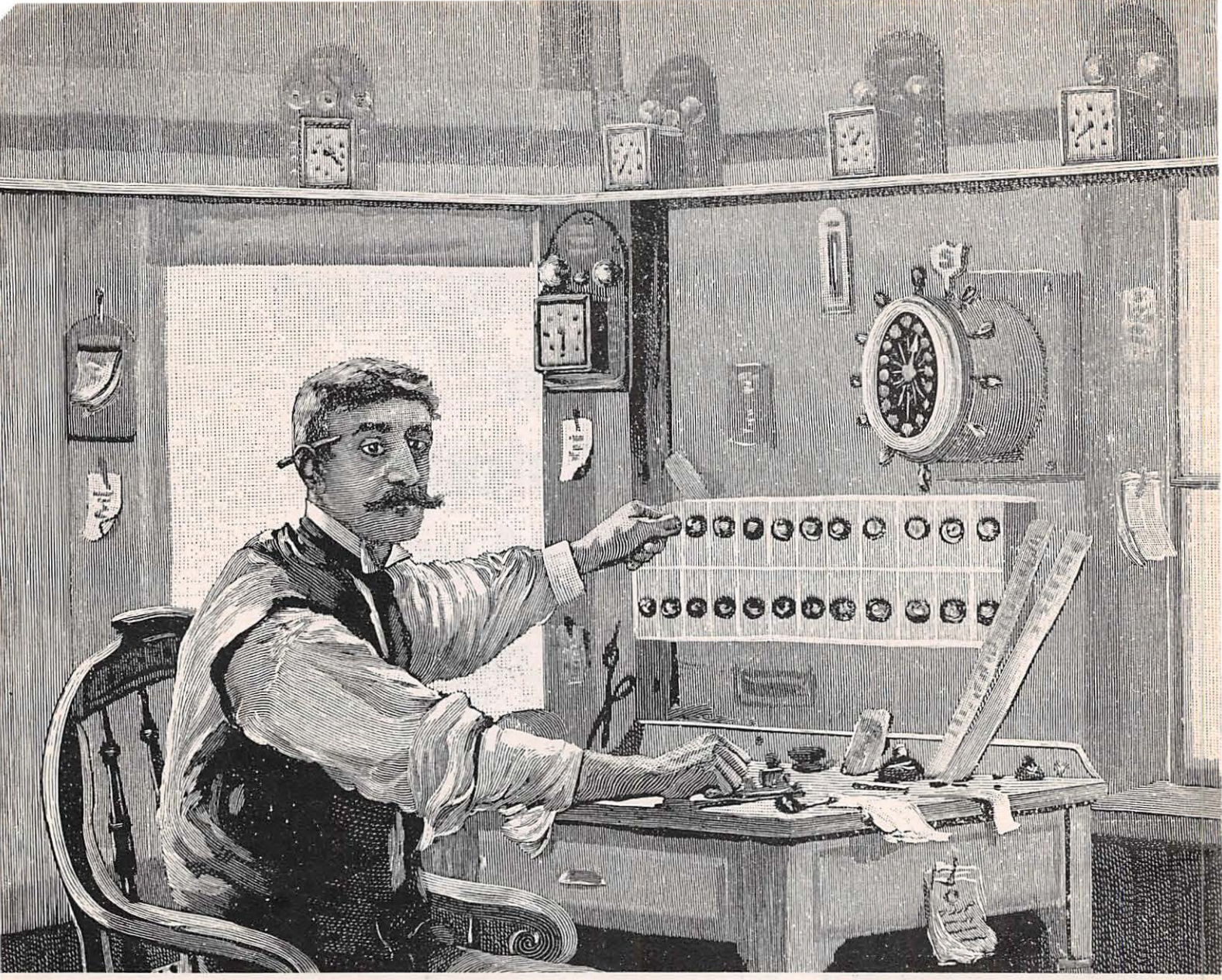

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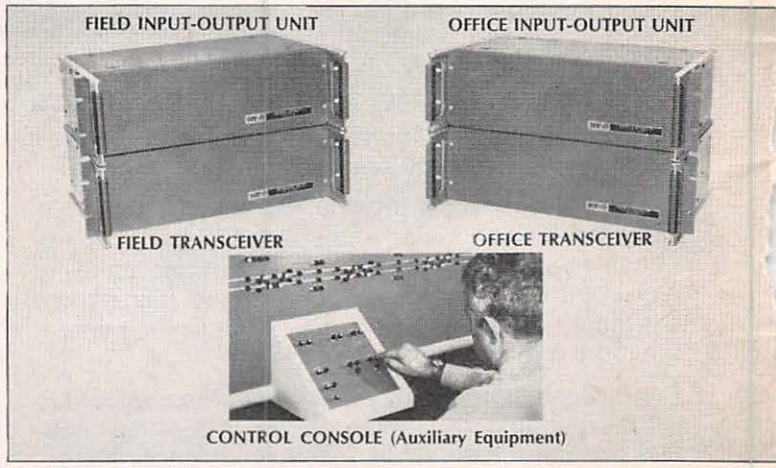

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NOVEMBER 1970 VOL. 1 NO. 8

RSC RAILWAY SYSTEM CONTROLS

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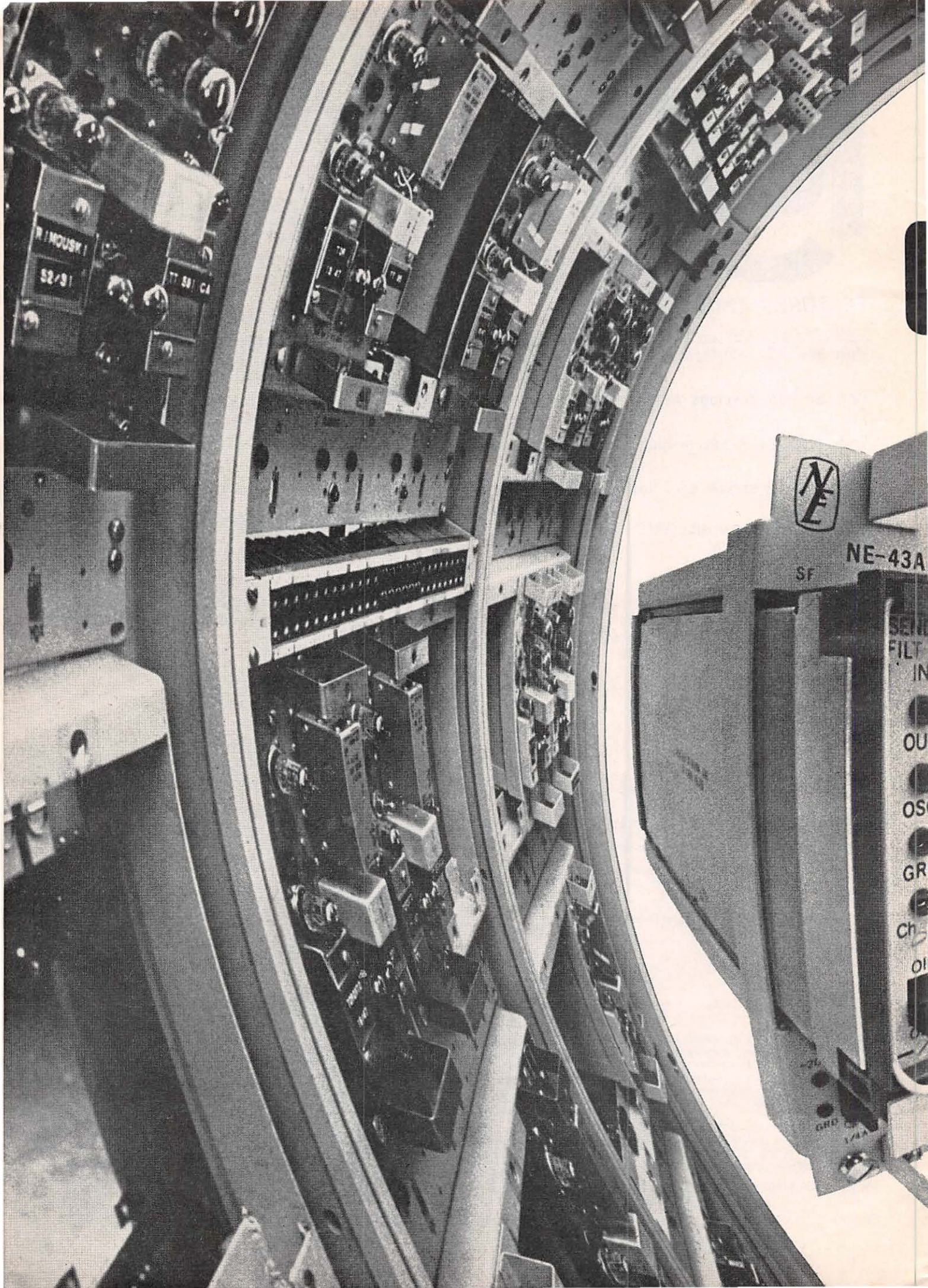
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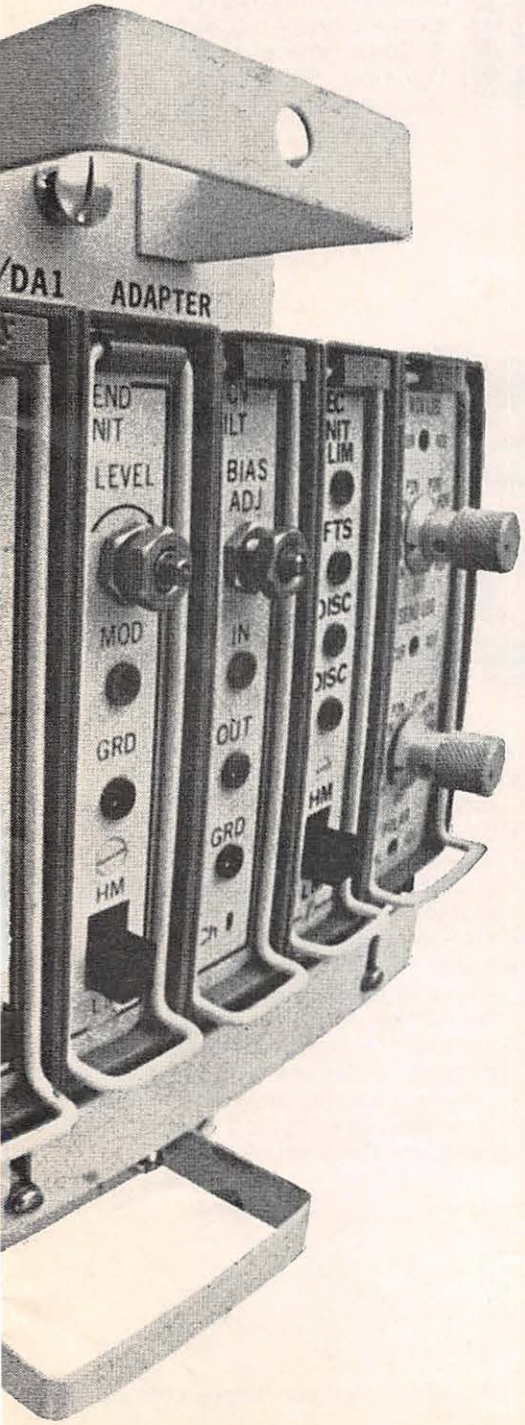

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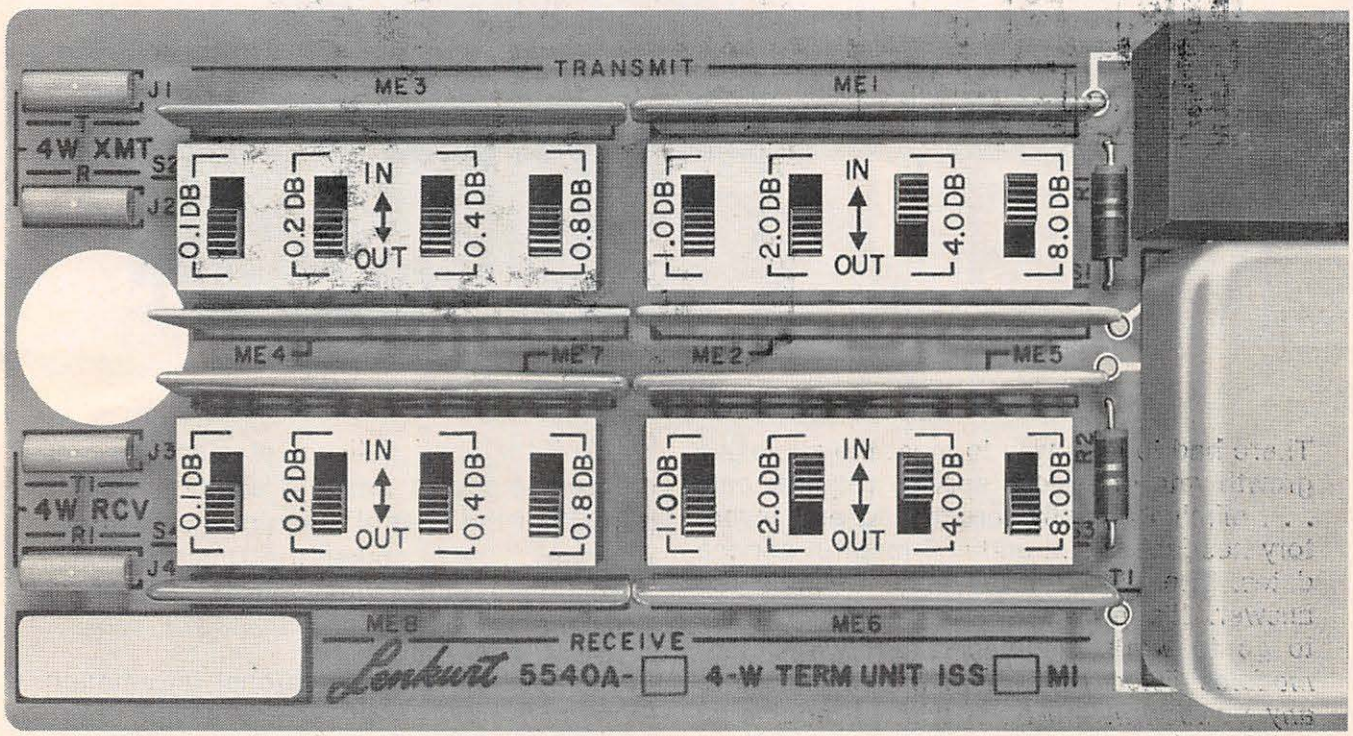

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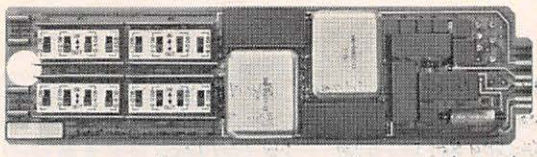

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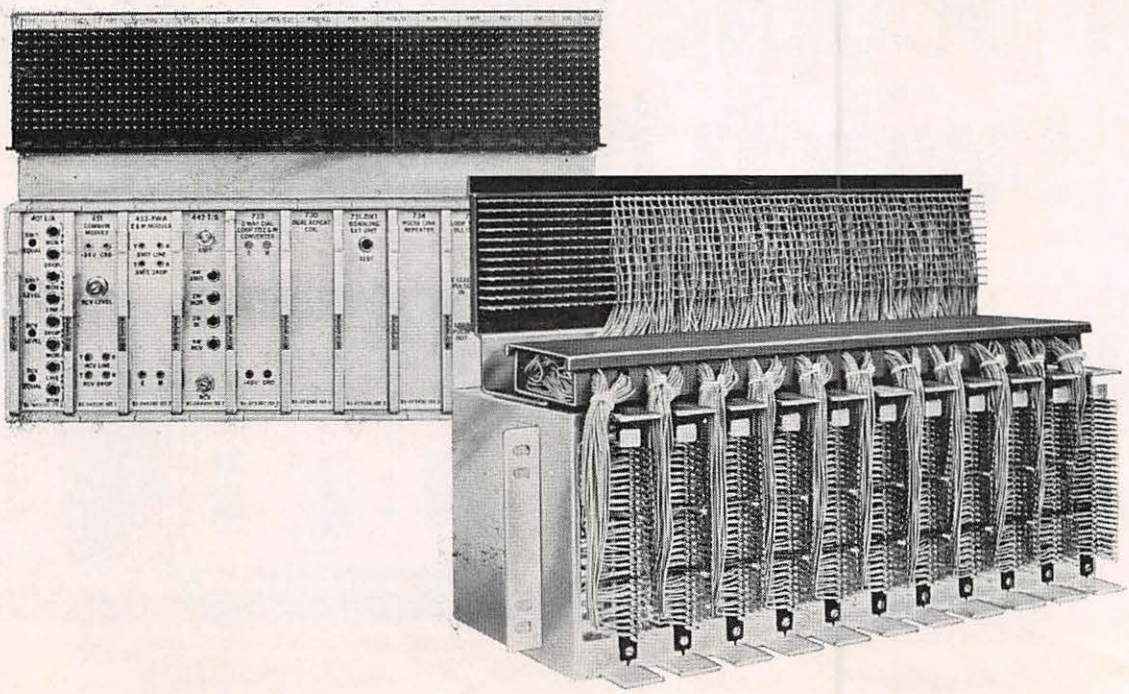

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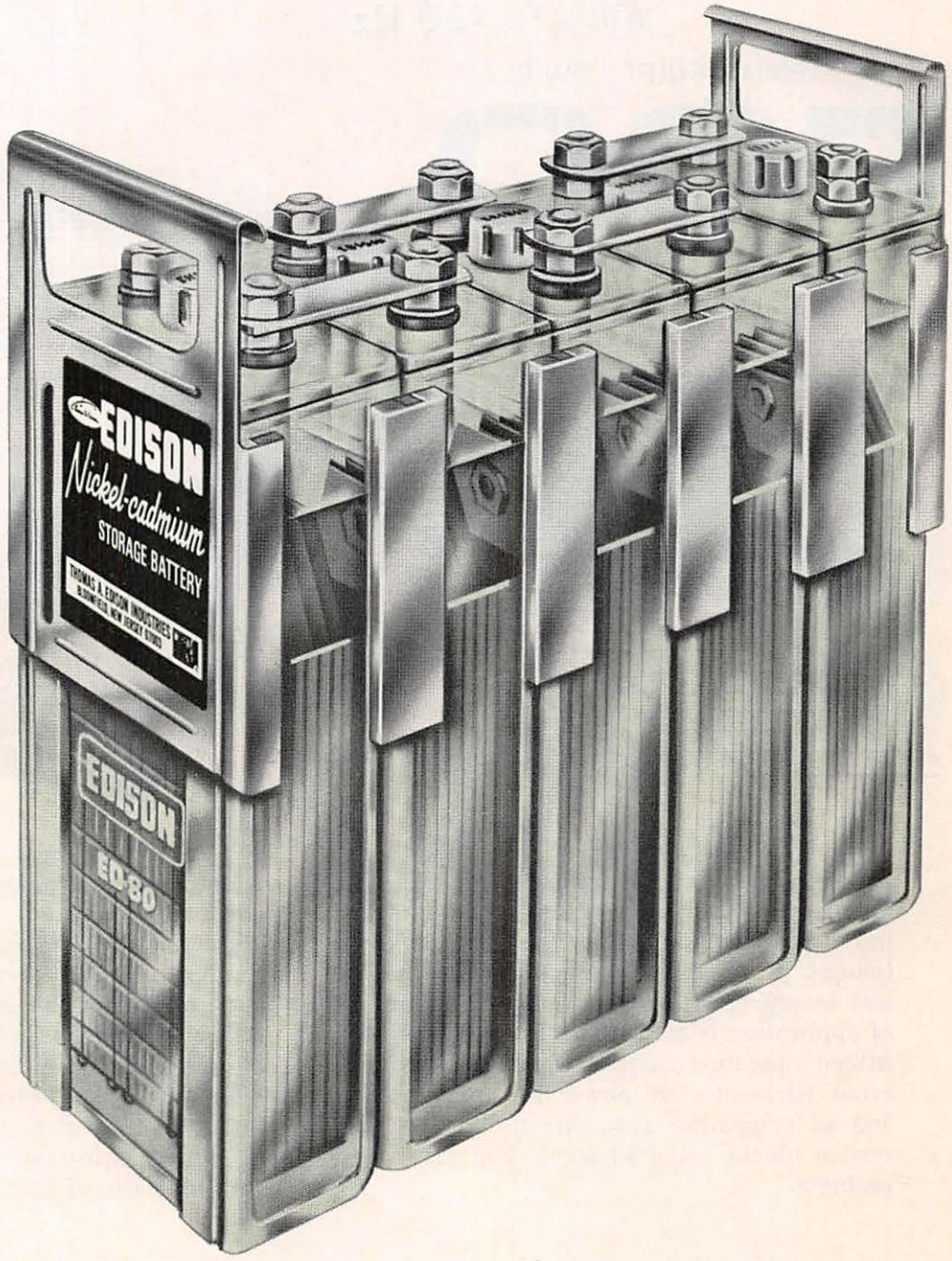

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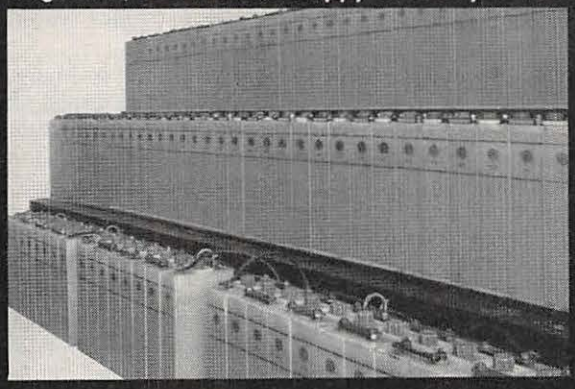

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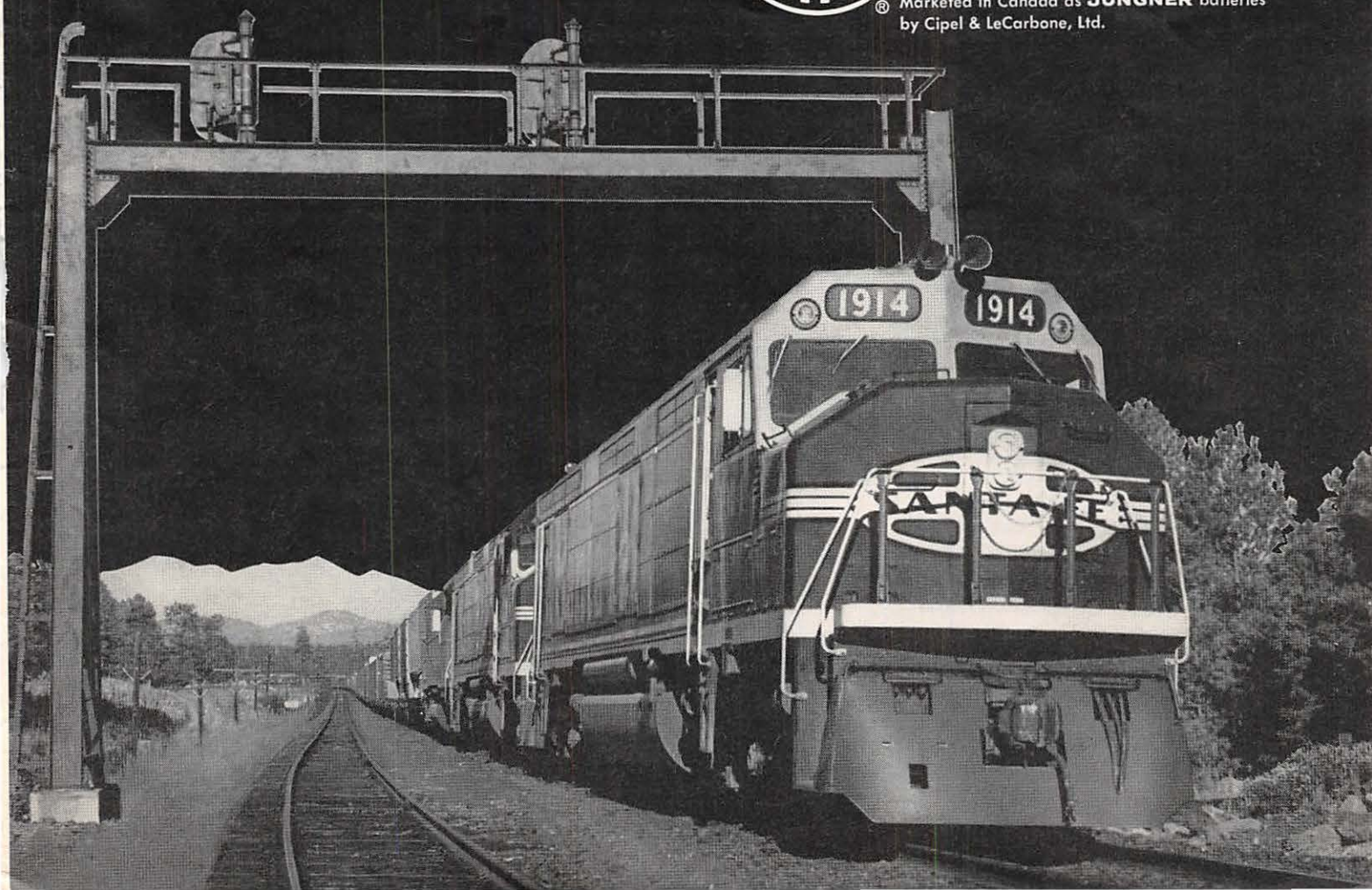


AAR's C&S Section develops inter

Recognizing that installation and maintenance of automatic car identification hardware would come under the jurisdiction of communications and/or signal departments—whether performed by the railroads or manufacturers—the Data Systems Division, AAR, Ad Hoc Committee on Automatic Car Identification Installation suggested that the Communication & Signal Section, AAR, form an Ad Hoc Committee to Study and Develop ACI Hardware Standards.

Such a committee held its first meeting in Chicago on Dec. 10, 1969. Chairman of the Ad Hoc Committee is C. A. Crouch, superintendent of communications, system, Santa Fe. First task was to prepare communications interface specification, which was approved by the C&S Section at its annual meeting in San Francisco, Sept. 15.

Below is some of the philosophy behind the specification and examples of the two major types of operation handled by the interface equipment. This material was prepared by Mr. Crouch. Following his comments are the ACI hardware-communications interface specification. This is the first in a series of articles by C. A. Crouch on the important work of his ad hoc committee. Future articles will deal with ACI recommended maintenance practices, and test labels for checking upon the operation of ACI scanners.

Being aware that a standard interface between the ACI equipment and line control equipment must be flexible and at the same time, limited in scope, the committee, in assigning the parameters to the AAR standard interface, gave careful consideration to the following:

- Many railroads have already established the design criteria for their telecommunications networks.
- ACI interface should not be the controlling factor in design of future telecommunications networks.
- The majority of the existing telecommunications networks employ some form of polling, making it necessary that the AAR interface respond to controls from a selector.
- All selectors will not have the same circuit arrangements. If special features are required to adapt the line equipment to the standard interface, they should be provided on an auxiliary panel installed between the ACI equipment and the line control equipment.
- The interface controls should be independent of the data signal code

MANAGEMENT INFORMATION

Most standards are developed to improve reliability, reduce production costs (through mass production) and provide compatibility. This has been accomplished by the Communication & Signal Section, AAR, which has developed a communications interface specification for automatic car identification.

The hardware interface is the device placed between the decoder output from the ACI scanner and the connecting communications lines.

An important consideration in developing the interface equipment is to provide for the polling of the ACI equipment by a selector under the control of a computer or similar central processing unit.

The interface specification was approved by the Communication & Signal Section, AAR, at its annual meeting in September 1970 in San Francisco, Calif.

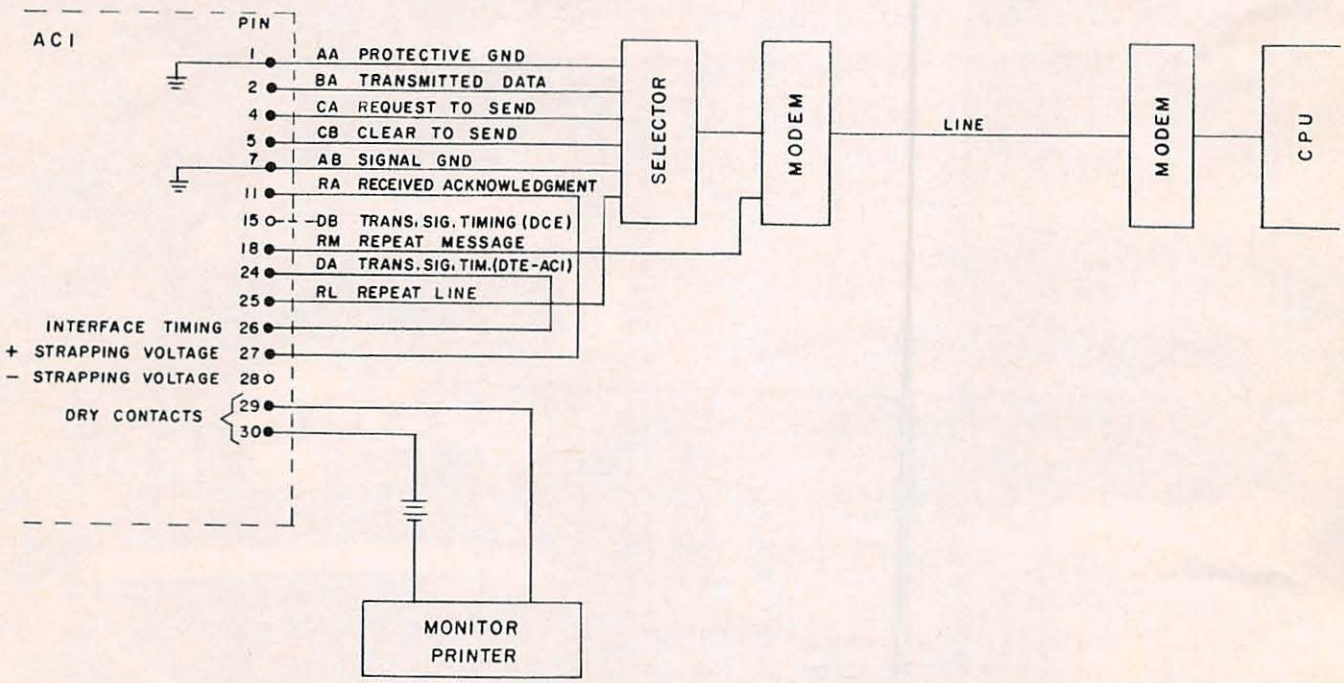


FIGURE A—Typical connections of interface where the CPU is not required to acknowledge after transmission.

face standard for ACI

and the speed of transmission.

- Interchange circuits should be consistent with EIA standard RS-232-C, in so far as practical.
- A standard interface should not limit the manufacturer from making improvements or modifications in his product (one manufacturer has already provided an additional option).

The interface, which is connected to a selector that can be polled by a computer or central processing unit (CPU), was designed to operate according to two basic philosophies:

Philosophy A is based on the premise that all information transmitted from the ACI is received by the CPU *without* change in form or character unless the CPU advises to the contrary. This method of operation does not require that the CPU send an acknowledging signal after each transmission of ACI data.

Philosophy B is based on the premise that information transmitted from the ACI is received by the CPU *with* change in form or character unless the CPU advises to the contrary. The CPU must send an acknowledging signal after each transmission of data.

The AAR interface will accommodate both of these philosophies or modes of operation. While there may be many variations in circuitry, the following examples will show how these philosophies may be developed in practical applications:

System A—Let us assume the CPU is connected to the ACI interface as shown in Figure A.

When the ACI buffer has recorded a complete train, circuit CA-Request to Send, will transfer to ON condition. It will remain in this condition as long as there is information in the buffer ready for original or repeat transmission. The selector on receipt of the next poll from the CPU will recognize the circuit CA ON condition and transfer circuit CB-Clear to Send to ON condition and connect circuit BA-Transmitted Data through to the CPU.

The ACI equipment will start transmission of the train message to the CPU and transmission will continue until circuit CB-Clear to Send is transferred to OFF condition or train message is completed.

At the end of the train message, the buffer must be programmed to send characters such as EOT which will be recognized by the selector as end of transmission. After transmitting EOT, the ACI will stop transmission, but circuit CA will remain in ON condition even though no additional messages are ready for transmission. The selector on receipt of EOT will transfer the signal on circuit CB-Clear to Send to OFF condition. Circuit RA-Received Acknowledgement, being strapped to positive battery, will automatically acknowledge receipt of message with no signal from the CPU.

If no command is received from the CPU on either circuit, RL-Repeat Line or RM-Repeat Message during the time circuit CB-Clear to Send is in OFF condition, transmission will be continued without repeat when the ACI is again polled and circuit CB-Clear to Send is returned to ON condition.

If during the OFF condition of circuit CB-Clear to Send either circuit RM or RL are transferred to ON condition for 5 milliseconds, the indications received will take preference in the following order: Repeat Message over Repeat Line over Received Acknowledgement.

On receipt of the next ON signal on circuit CB-Clear to Send, the ACI will back up and retransmit in accordance with the command received, continuing transmission until end of message or transfer of signal on circuit CB to OFF

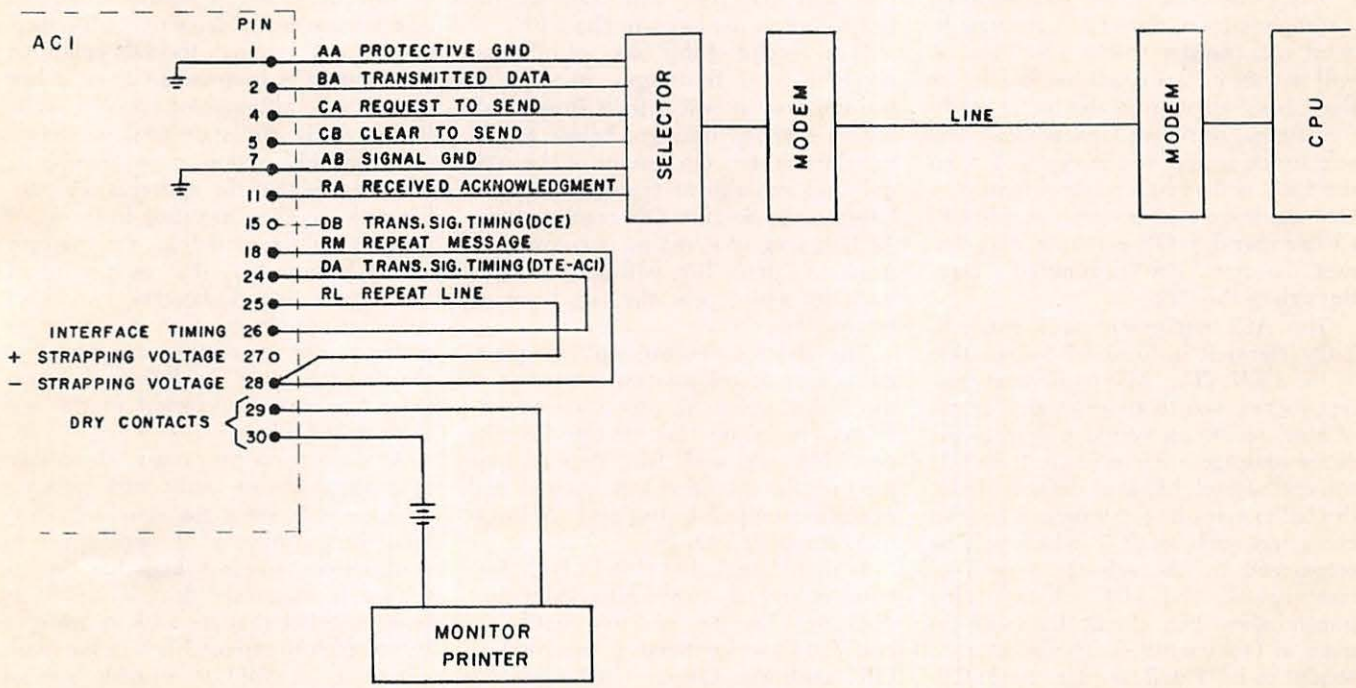


FIGURE B—Typical connections of interface where CPU sends acknowledgement after each transmission from ACI.

condition.

If during transmission the CPU recognizes a bad parity, it will send a control signal to the selector. The selector will transfer circuit CB-Clear to Send to OFF condition stopping transmission. The CPU will then address the selector connecting the receive leg to circuit RL-Repeat Line. The CPU will then send a message to circuit RL comprised of any signal having a spacing pulse of 5 milliseconds. (Selector must normally apply a marking or negative signal to the RL-Repeat Line circuit).

Computer will repoll selector and transfer circuit CB-Clear to Send to ON condition and ACI will retransmit the last two lines and continue to end of message or such time as circuit CB is again returned to OFF condition by CPU or the Modem equipment.

In this example, Circuit RM-Repeat Message is connected to the Carrier Detect Circuit in the Modem equipment. When carrier is lost, circuit RM-Repeat Message will be transferred to ON condition by action of the Modem and the selector will transfer circuit CB-Clear to Send to OFF condition stopping transmission. Because the carrier may be lost for several hours and it is not desirable to hold part of a message in the computer for an extended period of time, it is desirable to have the entire message repeated. This is accomplished by the command to circuit RM-Repeat Message.

System B—Let us assume the Central Processing unit (CPU) is connected to the ACI interface as shown in Figure B.

When the ACI buffer has recorded a complete train, circuit CA-Request to Send will transfer to ON condition. It will remain in this condition as long as there is information in the buffer ready for original or repeat transmission. The selector on receipt of the next poll from the CPU will recognize the Circuit CA ON condition and transfer circuit CB-Clear to Send to ON condition and connect circuit BA-Transmitted Data through to the CPU.

The ACI equipment will automatically transmit a block of information to the CPU. (The ACI equipment may be programmed to transmit any length of block including from one word to the entire message, such as entire train.) At the end of each block as defined above, the buffer must be programmed to send characters such as EOT which will be recognized by the selector as end of transmission. The ACI will then stop transmission, but circuit CA will remain in ON condition. The selector on receipt of EOT will transfer circuit CB-Clear to Send to OFF condition.

Men who wrote interface standard

C. A. Crouch, superintendent of communications, system, Santa Fe, chairman.

J. A. Early, manager communications & signal design, Penn Central.

M. W. Hewett, senior communications engineer, Southern.

G. L. Hitt, assistant to director of communications, Illinois Central.

D. C. McCuaig, communications system supervisor, Canadian Pacific.

P. G. O'Malley, regional signal engineer, Canadian National.

F. N. Pittman, assistant communications engineer, Southern Pacific.

H. M. Robertson, assistant to superintendent of communications, Union Pacific.

W. K. Schomburg, data communications engineer, Union.

Paul E. Dunn, manager logic & communications development, Signal & Communications division, Westinghouse Air Brake Co.

J. L. McNabb, engineer, Communications & Signal Section, AAR.

B. L. Arnold, senior staff engineer, Lenkurt Electric Co. Inc.

M. W. Baty, project supervisor, product development, Teletype Corp.

W. P. Boothroyd, senior staff engineer, Commercial Electronics division, GT&E Information Systems.

L. A. Payseure, manager communications & signal research, Chesapeake & Ohio/Baltimore & Ohio.

A. H. Ford, senior field systems center representative, IBM Corp.

The CPU will analyze the information and if no errors are noted, will address the selector and send an acknowledgement signal to circuit RA-Received Acknowledgement.

The CPU will then poll the selector in the usual manner transferring circuit CB-Clear to Send to ON condition and the ACI will transmit the next block or message to the CPU.

If on receipt of this block of information the CPU recognizes an error in transmission, it will refrain from sending an acknowledgement before repolling the selector. On receipt of the next poll and subsequent transfer of circuit CB-Clear to Send to ON condition, the ACI, having received no acknowledgement on circuit RA, will automatically back up and repeat the last block of information.

The above procedure will be repeated as long as information is present in the buffer and ready for transmission. It may be noted that circuits RM-Repeat Message and RL- Repeat Line have not been used in this example and must be strapped to terminal 28 Negative Strapping Voltage.

It should be noted that in both Systems A and B, the acknowledgement does not become effective until circuit CB-Clear to Send is returned to ON condition. Circuit CA-Request to Send will, therefore, remain in ON condition when there is no additional information ready for transmission until the selector is again polled and circuit CB-Clear to Send is transferred to ON condition.

Based on the assumption that this procedure may not be compatible with the programming of the computer, one manufacturer has provided an option that automatically decrements the train counter and removes the ON condition on circuit CA-Request to Send when there is no additional information in the buffer ready for transmission. Before ordering this option, care should be taken to see that the option is compatible with all other operating features.

It should be noted in the example covering System A that on receipt of the repeat line indication two lines were retransmitted. This was done to preclude the possibility of repeating the line following the line in question when an error is detected in the last character of a line.

As mentioned previously, the above examples indicate only two possible arrangements using the standard interface. In considering its application to your system, you will find that the interface is extremely flexible and it is recommended that its various features be completely explored before the manufacturer is asked to provide special equipment for your use.

ACI interface specs approved by C&S men

Automatic car identification hardware-communications interface will be included in AAR's Communication and Signal Manuals.

At the recent 10th annual meeting of the Communication & Signal Section, AAR, approval was given to a specification for inclusion in the Communication and Signal Manuals on Automatic Car Identification Hardware-Communications Interface. The specification was prepared by the Ad Hoc Committee to Study and Develop ACI Hardware Standards under the chairmanship of C. A Crouch, superintendent communications, system, Santa Fe.

Here are the specifications:

A—Purpose

A-1. The purpose of this specification is to guide the manufacturer in the supplying of a Standard ACI interface for use in the communication plant.

B—Drawings and Specifications

B-1. Drawings referred to: EIA-DB-19604-432—25 pin male plug, *Cannon* or *Cinch;* EIA-DB-51226-1—Hood for above plug.

B-2. Specification referred to: EIA Standard RS-232-C.

C—General

C-1. The text of this specification and the specifications and drawings referred to under Section B are intended to supplement each other, so that any detail indicated in one and not in the other shall be executed the same as if indicated in both, unless exceptions are specifically mentioned within the body of this specification.

C-2.1 Interchange circuits between all units making up the total system, if to be brought out to interconnecting terminals, and are within the scope of EIA Standards RS-232-C, "Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange," shall be consistent with this EIA Standard RS-232-C insofar as it is practical to do so.

C-2.2 *Interchange Circuits Between the ACI Serializer and Code Converter as Provided by the Manufacturer and Line Control Equipment as Provided or Specified by the Customer.*

Because each railroad now has or will adopt a system of line discipline peculiar to the specific requirements of that railroad, the interface requirements between the output of the ACI and the line control equipment may vary on each application.

The interface described below has been recommended after due consideration was given so as to provide a maximum number of operational possibilities at the output of the ACI serializer and code converter within the present economical design limitations of the equipment.

It is recommended in cases where existing line control equipment, data communications equipment or line discipline is not compatible with these standards, a separate device be installed between the above equipment and the ACI equipment to provide the functions necessary rather than require the manufacturers to make special modifications.

C-2.2.1 Terminal block(s), minimum 30 terminals, shall be provided as part of the ACI equipment from which a 25 conductor EIA cable may be connected to the first 25 pins. A 25 conductor cable with an EIA male connector 25 pin plug type Cinch or Cannon DB-19604-432 and hood DB-51226-1 or equivalent shall be provided with the ACI equipment. This cable shall be not less than 15 feet.

The female connector shall be associated with, but not necessarily be physically attached to the line control or data communications equipment. Positive and negative signal strapping voltages shall be provided on additional terminals 27 and 28 respectively.

C-2.2.2 Electrical signal characteristics of all interchange circuits shall conform to EIA Standard RS-232-C Section [illegible] "Electrical Signal Characteristics."

C-2.2.3 *Pin and Terminal Identification.*

Assignment listed below shall be used:

Pin Number	Circuit	Description
1	AA	Protective Ground
2	BA	Transmitted Data
4	CA	Request to Send
5	CB	Clear to Send
7	AB	Signal Ground (Common Return)
11	RA	Received Acknowledgment
15	DB	Transmission Signal Element Timing (DCE)
18	RM	Repeat Message
24	DA	Transmission Signal

Specification is for interface equipment to connect to communications lines

		Element Timing (DTE-ACI)
25	RL	Repeat Line

Terminal Number	Description
26	Interface Timing
27	Positive Strapping Voltage
28	Negative Strapping Voltage
29)	Dry Relay Contact
30)	90 MA Maximum

C-2.2.4 *Functional Description of Interchange Circuits as Applied to the ACI Equipment.*

The description contained in this section covers the internal functions within the ACI equipment as related to the interchange circuits. It is based on all interface cards and a buffer being present in the ACI equipment and without regard to any given system of line discipline.

If functions that are not required in the purchaser's system are present in the ACI equipment certain strappings of the interface pins as designated in 2.2.1 and 2.2.3 may be necessary.

C-2.2.4.1 *Circuits AA & AB-Protective Ground and Signal Ground* shall conform to EIA Standard RS-232-C paragraph 4.4 "Interchange Circuits." Protective Ground and Signal Grounds shall both be grounded in ACI equipment only and carried over to the line control or data communications equipment.

C-2.2.4.2 *Circuit BA-Transmitted Data.*

Signals on this circuit are generated by the ACI equipment. The ACI equipment shall hold circuit BA in marking condition during intervals between characters or words and at times when no data is being transmitted.

Signals transmitted on this circuit will be either 5-level Baudot or 8-level ASCII (X3.4 1968) codes. Other codes will be provided by manufacturer only by special arrangement.

If at end of message circuit CB-Clear to Send changes from circuit ON to circuit OFF condition and no acknowledgment is received or present on Received Acknowledgment terminal, the last message will be repeated when circuit CB-Clear to Send returns to ON condition.

If acknowledgment is received or present on Received Acknowledgment terminal under conditions described above, the next message will be sent when circuit CB-Clear to Send returns to ON condition.

C-2.2.4.3 *Circuit RA-Received Acknowledgment.*

This circuit is used to acknowledge receipt of entire message.

A circuit ON (positive) pulse of 5 milliseconds minimum duration or a series of pulses such as a character in either the 5-level Baudot or 8-level ASCII code applied to Received Acknowledgment terminal during a circuit OFF condition on circuit CB-Clear to Send indicates an acknowledgment of receipt of message.

A circuit OFF (negative) condition shall be applied to Received Acknowledgment terminal during intervals between acknowledgment indications.

A circuit ON (positive) strapping voltage may be strapped to Received Acknowledgment terminal to automatically acknowledge end of message each time circuit CB-Clear to Send indicates a circuit OFF condition.

C-2.2.4.4 *Circuit CA-Request to Send.*

The ON (positive) condition on this circuit indicates that the data is ready for transmission.

This circuit will remain in the ON condition whenever there is data in the ACI equipment ready for transmission.

C-2.2.4.5 *Circuit CB-Clear to Send.*

The ON (positive) condition on this circuit indicates that the line control or communication equipment is ready to receive signals from circuit BA-Transmitted Data.

When OFF condition of circuit CB stops transmission at end of message and there is no acknowledgment signal, buffer will repeat entire last message when circuit CB returns to ON condition.

C-2.2.4.6 *Circuit RM-Repeat Message.*

An ON (positive pulse of 5 milliseconds minimum or a series of pulses such as a character in either the 5-level Baudot or 8-level ASCII code on this circuit is a request for the ACI equipment to return to the start of the message being sent and repeat entire message.

The request for repeat will only be recognized if it occurs during the OFF condition of circuit CB-Clear to Send and repeated transmission of train data will not start until circuit CB returns to ON condition.

The ON condition on this RM circuit will override an acknowledgment on RA-Received Acknowledgment terminal or a pulse received on circuit RL-Repeat Line.

The circuit OFF (negative) condition shall be applied to this circuit during intervals between ON (positive) conditions.

C-2.2.4.7 *Circuit DB and DA* are timing circuits and shall conform to EIA Standard RS-232-C Sections Two and Four.

C-2.2.4.8 *Circuit RL-Repeat Line.*

An ON (positive) pulse of 5 milliseconds minimum or a series of pulses such as a character in either the 5-level Baudot or 8-level ASCII code on this circuit is a request for the ACI equipment to repeat the last line being transmitted.

This request for repeat will only be recognized if it occurs during OFF condition of circuit CB-Clear to Send and repeated transmission will not start until circuit CB returns to ON condition.

The ON condition on this circuit will override an acknowledgment on RA-Received Acknowledgment Terminal.

C-2.2.4.9 *Circuit–Local Loop.*

Transmit Only contacts shall be provided on pins 29 and 30 of Terminal Block(s) 2.2.1 rated for 260 volts 0.090 amperes, maximum Baud rate: 200.

C-2.2.5 *General Explanation of Interface.*

The EIA Standard interchange cir-

cuits AA-Protective Ground, BA-Transmitted Data, CA-Request to Send, CB-Clear to Send, AB-Signal Ground and DB and DA-Transmission Signal Element Timing are provided. In addition, circuits RA-Received Acknowledgment, RM-Repeat Message and RL-Repeat Line have been established. These three additional circuits provide the controls needed to fit the specific requirements peculiar to the various users' overall system.

Circuit RA-Received Acknowledgment is used in systems providing an acknowledgment after each train message. The acknowledgment must be transmitted to the ACI during the interval between the removal of the ON condition on the CB-Clear to Send circuit and the next polling of the ACI. If no acknowledgment is received during this time, the last complete train message will be repeated on receipt of the next poll. If acknowledgment is received during this period, on receipt of the next poll, transmission of the following train message, if present, will be started.

The number of times a complete train message will be repeated will be controlled by circuits external to the ACI equipment.

Circuit RM-Repeat Message is used in systems requiring repeat of entire last train message or part thereof on request. The request signal must be applied to circuit RM when circuit CB-Clear to Send is OFF condition. The application of OFF condition to circuit CB may be done at any time from the start of transmission of the header until the ACI receives the next poll.

If a request is received during the time as described above, the buffer will return to the beginning of the train message just completed or being transmitted and repeat the message on receipt of next poll.

Circuit RM-Repeat Message will override any signal that may have been or is present on circuits RA-Received Acknowledgment and RL-Repeat Line between the OFF condition circuit CB-Clear to Send and the receipt of the next poll.

Circuit RL-Repeat Line is used in systems requiring the repeat of the last line or last two lines of data. Generally such systems use parity check of each character. On receipt of false parity, the CPU will cause circuit CB-Clear to Send to go to OFF condition and an ON signal to be applied to circuit RL-Repeat Line. On receipt of next poll, the ACI equipment will repeat the last line or two lines.

It should be understood that because of the time required to perform the above operations, there is a possibility that if the false parity occurs on the last character of a line, transmission may start on the following line before circuit CB goes to OFF condition. If the above should occur, the following line would be repeated rather than the preceding one in which the error occurred. For this reason, it may be desirable to repeat the last two lines.

Circuit RL-Repeat Line will override any signal that may have been or is present on circuit RA-Received Acknowledgment during the OFF condition of circuit CB-Clear to Send and the receipt of the next poll.

Timing Circuits DA and DB

The option to use either ACI or data modem timing shall be provided on terminal block(s). The modem timing shall be terminal 15(DB). The ACI timing shall be Terminal 24(DA). The ACI interface timing shall be from Terminal 26, Terminals 15 or 24 shall be strapped to 26 for modem or ACI timing respectively.

D—Material and Workmanship

D-1 Material and workmanship shall be first-class in every respect.

D-2 Terminal block(s) shall be of commercially available type(s).

F—Identification

F-1 Each terminal on terminal block(s) (C-2.2.1, C-2.2.3 and D-2) be clearly identified by: a. Number (C-2.2.3) b. Circuit (C-2.2.3)

G—Inspection and Tests

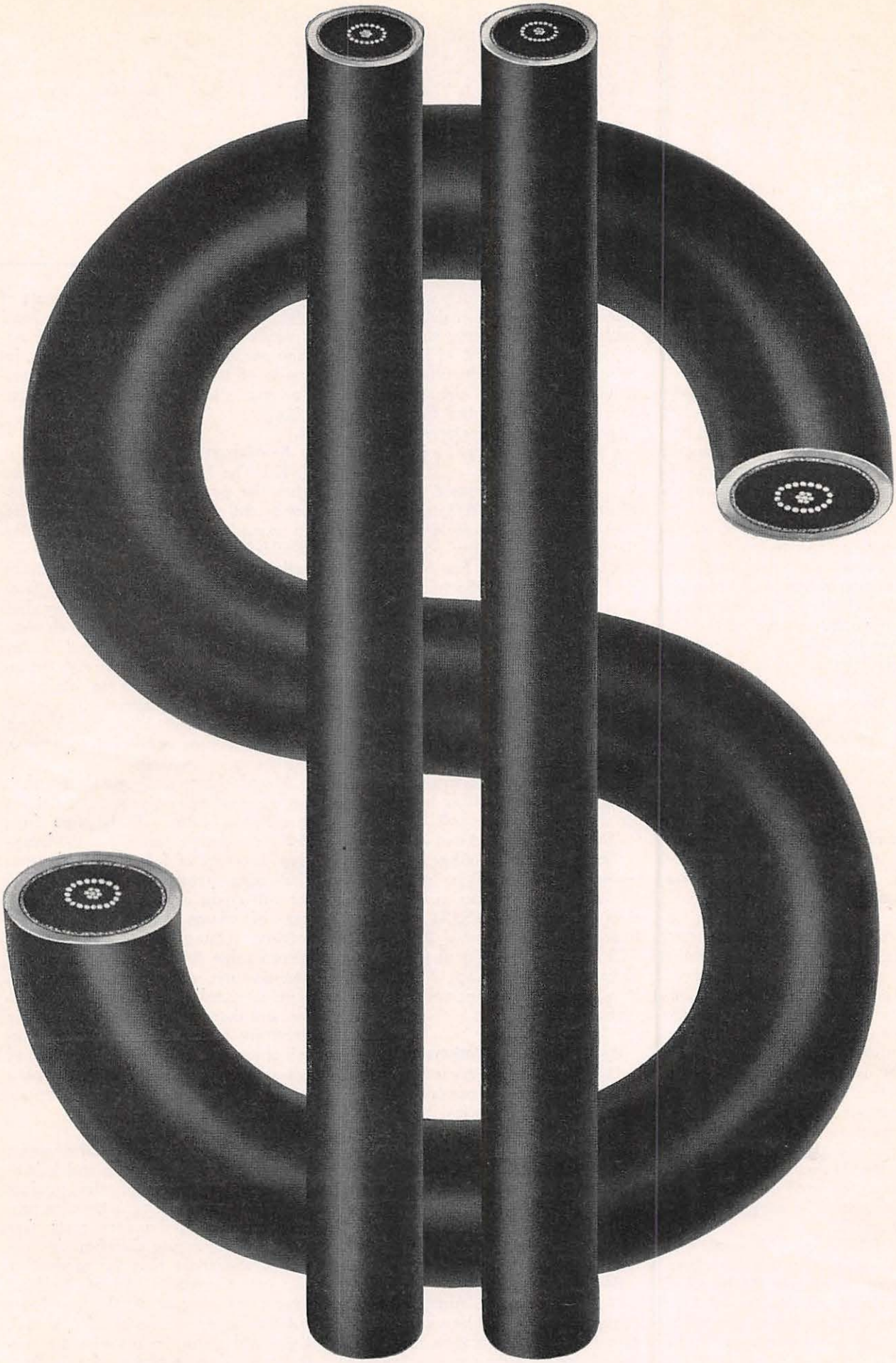
G-1 The product furnished under this specification may be accepted upon manufacturer's certification that it is in accordance with the specification. If on arrival at destination the product is found not to meet the requirements of the specification, it may be rejected and manufacturer, upon request, shall advise purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all transportation charges.

K—Warranty

K-1 The Manufacturer shall warrant that the product, including all accessories and replacement parts, supplied in accordance with this specification shall be free from defects in design, material or workmanship under ordinary use and service within one year from date of acceptance. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the manufacturer thereof, so as to affect, in manufacturer's judgment, its proper functioning or reliability, nor to that which has been subjected to misuse, negligence or accident.

Manufacturer shall guarantee that, for a period of one year from date of installation, cable will be free from defects in design, material or workmanship. In event of failure, manufacturer shall allow return of defective cable for full credit or will replace in kind free of charge f.o.b. destination of original shipment. In latter case replaced cable shall become property of manufacturer at said destination, but purchaser shall not be held responsible for any damage to defective cable in removing or rereeling it. Manufacturer's obligation under this warranty shall not apply to any cable which has been subjected to misuse, negligence or accident after acceptance.

K-2 The manufacturer shall covenant and agree to save harmless and indemnify the purchaser of the product against all claims, suits, actions, or proceedings and all damages, costs, fees and expenses arising therefrom by reason of allegations that the product or any part thereof in and of itself infringes any patent if the purchaser notifies the manufacturer of any such claim and gives the manufacturer authority to dispose of it and to defend any suit brought thereon.



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What is train-stop criteria for hb

Experience of two major railroads with hotbox detectors was discussed at the recent annual meeting of the Communication & Signal Section, AAR. Abstracts from two papers are presented: first the views of N. C. Pace, assistant to vice-president communications, Southern; followed by those of J. M. Hesser, assistant manager, communications and signals, Norfolk & Western.

Are we stopping too many trains with suspected hotboxes? Pace asked. We think so especially in the case of roller bearings. A recent careful study of our data compiled over a period of several years reveals that about 30% of all stops are occasioned by suspected roller bearings. Further analysis revealed that almost 100% of all roller bearing stops are really stops that should not have been made. Almost 100%, but not quite. They were reported abnormally hot by train crews at the time and this does not fault the detector which was operating properly within its design criteria nor does it fault the crew. A later thorough inspection revealed no defect. Actually, only about 5 roller bearings out of 500 stopped in one year were shopped and rebuilt. Even at that rate only about 3 of this 5 exhibited signs of any appreciable damage which might have been regarded as dangerous or which possibly could have failed enroute.

This speaks well for roller bearing performance but perhaps not so well for Southern's detecting technique, especially insofar as roller bearings are concerned.

Actually, many roller bearings run in an overheated condition simply because they have been over-stuffed with grease, which, while not a good practice, causes little detriment to bearing performance, until such time as internal pressure build-up in the bearing housing, because of the elevated temperature, causes loss of lubricant by the grease literally blowing out of the housing through the seals. Once this loss of lubricant occurs, of course, the bearing faces the hazard of potential damage if continued in operation. Roller bearings can fail and we must continue to ferret out the ones that are likely to fail.

Through considerable research, it has been determined that roller bearings operate with reasonable safety when housing temperatures do not exceed about 200 deg. F above ambient.

Our detectors are calibrated to produce full scale strip chart indications of 25 mm, when observing test block temperatures adjusted to radiate at 125 deg. F above ambient. Our mandatory stopping criteria for roller bearings presently is full scale 25 mm representing 125 deg. F above ambient. Our mandatory stopping criteria for flat bearings is 18 mm relating to exhibited box temperature of 90 deg F above ambient.

We chose the 18 mm criteria in order to allow our observers to view, with more resolution, those indications of less than 18 mm in magnitude. The advantage of greater resolution allows the observer to better use his judgment in comparing suspected indications with other normal indications throughout a given train. This comparison technique offers far greater accuracy in detecting overheated journals than does any method utilizing an attempted fixed, pre-established, pip height criteria.

Obviously, but not too obviously, a computer could be designed to make these comparisons and decisions. However, the many variables and anomalies encountered would require quite a sizable and expensive computer and a very complex program.

While the greater resolution attained with the 18 mm criteria is fine for detecting overheated flat bearings, the linear response (Solid line on Chart No. 1) of the detector electronics causes indications to top out at 25 mm relating to 125 deg. F above ambient. This does not go high enough to allow viewing roller bearings in their proper suspectable range, at about 200 deg. F above ambient for representation of serious overheating. As a safety measure, we settled on 175 deg. F above ambient for this criteria.

We could change the gain in our detectors and telemetry systems to produce a response represented by the dotted line on Chart No. 1, topping out full scale, 25 mm, relating to 175 deg. F instead of 125 deg. F above ambient. But, see what this treatment does to our highly desirable resolution advantage for those indications derived from the 90 deg. F above ambient criteria. Instead of producing 18 mm pips, we see a pip of only 13 mm along with pretty drastic range reductions for those indications below that level. This is undesirable especially since our wheel count or so-called cold pip indications have been established at about 3 mm.

Obviously, in our situation, we need a detector and recorder system having a wider range of response in order to accommodate both flat and roller bearings and to maintain required resolution for those indications lower than our

MANAGEMENT INFORMATION

Experience indicates that in recent years railroads may be stopping too many trains for suspected hotboxes. Two railroads, namely Southern and Norfolk & Western, have examined the situation. Their findings are that many trains having roller-bearing equipped cars are being stopped because the journals are running at above normal temperatures. Also, the train crew which makes the judgement in the field, takes the safest course, i.e., set the suspected car out rather than take the chance of having a bearing fail with possible resultant derailment.

Over lubrication appears to be one possible cause of these bearings to run at elevated temperatures which actuates hotbox detectors. Improved journal bearing maintenance practices may reduce abnormal running bearings and decrease the number of train stops.

detectors?

established criteria of 18 mm for flat bearings.

This would require a strip chart having 35 mm full scale instead of the present 25 mm capability. Also, sophistication would be required in the system's electronics to provide the required linear response.

The problem was solved by one of our engineers, Roland A. Howell, who has been close to our hotbox detector developments. He made a step response modification in the detector preamplifier system to produce the response shown on Chart No. 2. The original response is not altered below the 18 mm step and from that point upward the response line, still linear, bends to top out, full scale, 25 mm, relating to 175 deg. F above ambient instead of 125 deg. F.

Howell accomplished these results through implementation of inverse feedback in the detector's preamplifier. The feedback function is only effective above as adjustable threshold point, in our case, established at 18 mm. The slope of the top half of the curve is also adjustable, in our case, adjusted to top out at 175 deg. F above ambient.

Our true-to-false stop ratio has, for several years, averaged about 65 or 70%. We expect to see our ratio improved to about 85 to 90% when all of our detectors are given this treatment. We must make some unnecessary stops in order to preserve a safety margin. Other detector modifications and improvements have contributed to our good batting average; such modifications as shorter and more stable gating time intervals, improved scanning geometry, improved pulse stretching technique, battery operation, etc.

Our method of calibration results in indications of about 6 mm for normal running flat bearings and about 12 mm for normal running roller bearings. Calibrations are made with reference to ambient temperature at the time of calibration and no changes in the detector's adjustments are required from summer to winter through a complete weather temperature cycle.

The phenomena that allows this calibration is not generally understood.

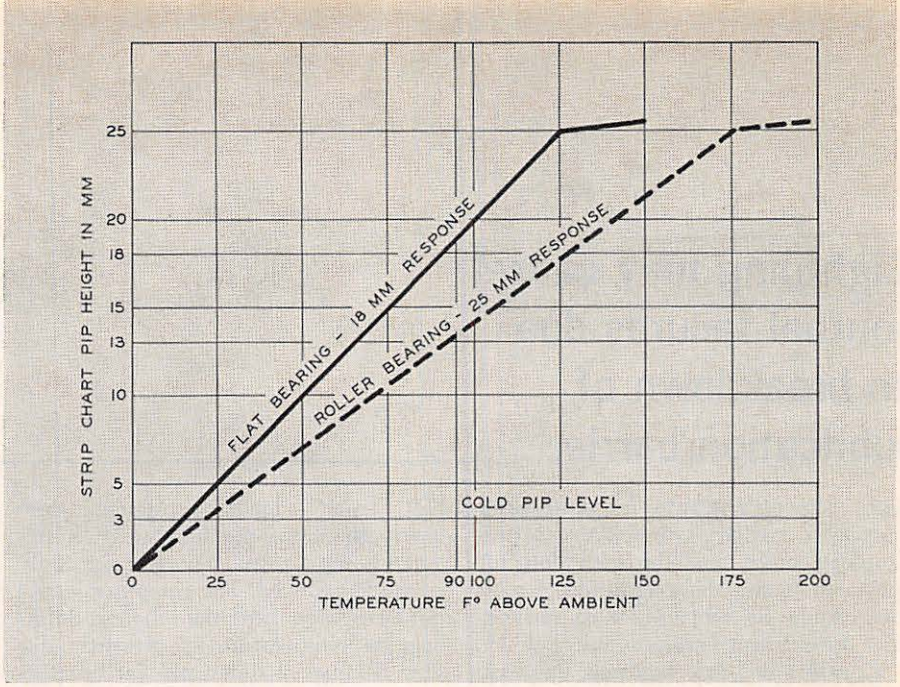


CHART NO. 1—Normal hotbox detector response on Southern.

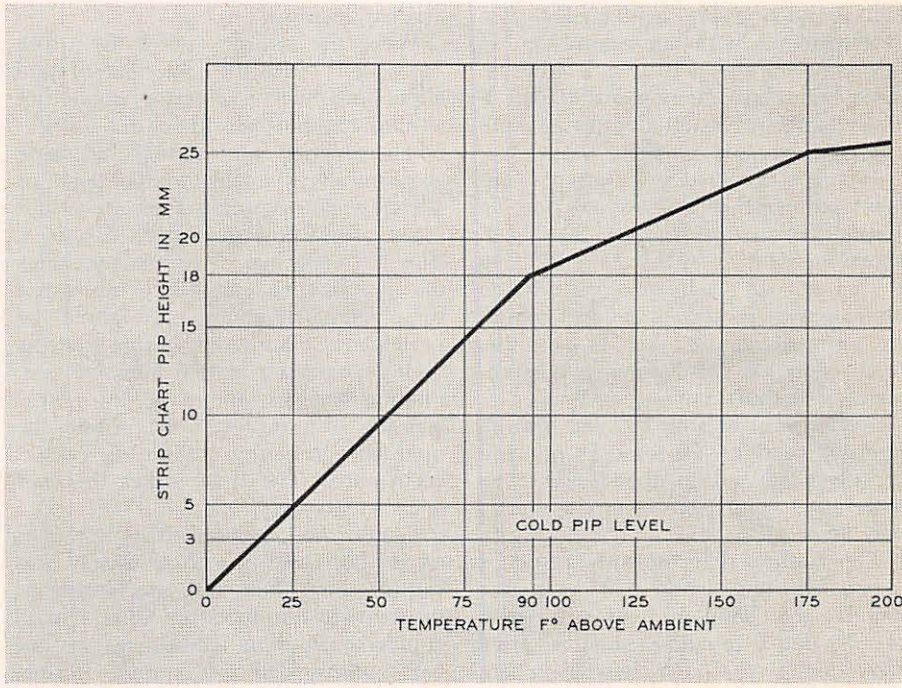
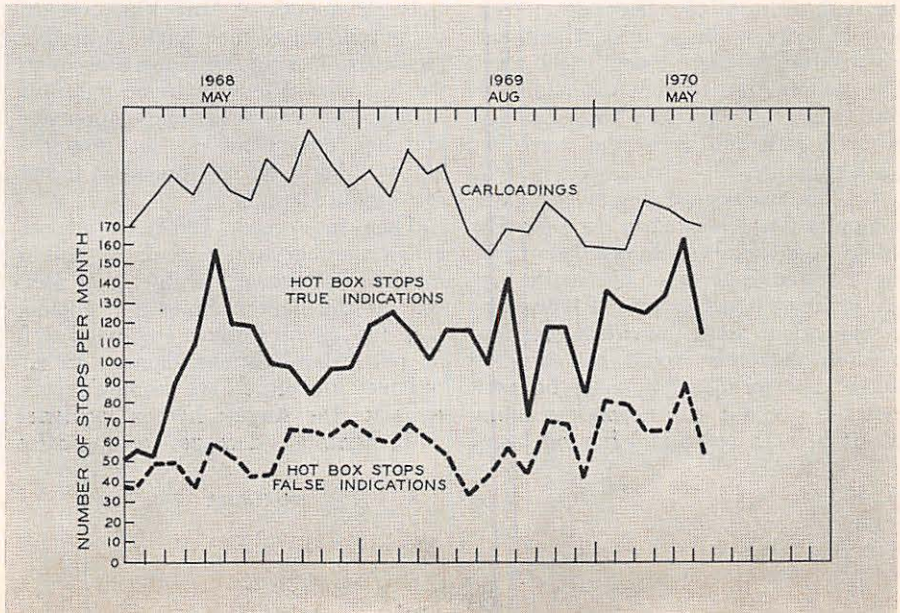


CHART NO. 2—Southern's modified hotbox detector response.

CHART NO. 3—Number of trains stopped by Southern's hotbox center.



Lightning may cause journal failures due to breakdown of lubrication barrier

The detector's thermistor bolometer output is capacity coupled to its preamplifier input and the final detector output indicates the magnitude of relative change in temperature on surfaces that the detector rapidly scans.

Consider this, in −10 deg F ambient, winter temperature, the normal running journal box temperature at 30 deg F above ambient or 20 deg F absolute will produce a pip height of 6 mm in accordance with our calibration. In this same winter, −10 deg F environment, a hotbox running at 90 deg F above ambient or 80 deg F absolute will produce a pip height of 18 mm.

Whereas, in 90 deg F summer ambient temperature the normal running journal box temperature at 30 deg F above ambient or in this case 120 deg F absolute will produce the same 6 mm pip as was produced in the winter environment at 20 deg F absolute. In the same 90 deg F summer environment, a hotbox running at 90 deg F above ambient or now 180 deg F absolute will produce the same 18 mm pip as was produced in the winter time with an absolute box temperature of only 80 deg F.

The hotbox detector only responds to change and could not care less whether the change is from −10 deg F to +80 deg F in cold weather or from +90 deg F to +180 deg F in hot weather so long as the change in each case is 90 deg F, the detector will produce a pip of 18 mm.

This assumes that the base reference, the undersides of cars between viewed journal boxes is always at near ambient temperature which is generally the case. The temperature of the undersides of cars is largely influenced by secondary infrared radiation from the earth or track structure.

In the absence of highly complex computer implementation to properly interpret and evaluate information from our infrared detectors, automation, in my opinion, is not practical. However, a tremendous assist toward automating infrared detectors would be afforded if the detector's output could be normalized; i.e., if all normal running bearings, both roller and friction bearings, could somehow produce more nearly the same pip height. With this assist, computer usage complexity could be vastly reduced. The computer would not have to consider the inherent difference in temperature as presently displayed between roller and flat bearings in making decisions. The danger or alarm threshold could then be established at the same point for both roller and flat bearings.

What the industry needs is a true "go-no-go" detector for line-of-road alarm use. Such a detector would not require extreme sensitivity for inspection evaluation and should be made economically available to the point of allowing close spacing between installations, say 5 to 8 or possibly 10 miles. This close spacing, of course, precludes the practice of centralized observing since communications cost would be prohibitive. Standard alarming systems such as signaling system interconnects, rotating beacons, automatic low power wayside transmitters, etc., could be used to alert train crews of hotbox occurrences. The crew makes the final decision anyway.

Would you believe that lightning causes hotboxes? We think so and can furnish some data and speculation to substantiate our thinking. Chart No. 3 depicts a running record, in part, of our hotbox detector system performance. The solid line represents valid stops and the dotted line represents false stops. The third line above relates to car loadings or traffic flow.

In the month of May 1968, we experienced an all-time high in hotbox incidence. During this same time interval, we also suffered extreme lightning damage to communications apparatus and line equipment on our property. Hot weather is not yet prevalent in our territory in May.

Then in August 1969, we experienced another minor peak in hotbox incidence. However, in this time interval, we did have summer hot weather and the usual summer lightning but no particular lightning damage to apparatus; therefore, we cannot really correlate the August hotbox incidence with lightning damage to apparatus with the certainty that we were allowed in May 1968.

But in May 1970, we had about the same hotbox incidence as in May 1968 and again during the same time interval we experienced heavy apparatus and line damage from known lightning storm occurrence.

In these two cases—May 1968 and May 1970—we would find it difficult to ignore the correlation between hotbox incidence and known lightning storm occurrence.

Knowledge of the ill effect of electric currents flowing across the lubricant barrier at a bearing journal interface is not something new and recently discovered. Knowledge of this phenomena exists and has been recognized by bearing technology for many years.

Also, knowledge of the insulating quality of common oil or grease lubricants has been around for quite sometime. We have actually measured the DC resistance existing across the lubricant barrier in a normally running flat bearing. With a potential difference of 5 or 6 millivolts between bearing surfaces the resistance to direct current flow across the lubricant barrier was found to be in the order of 2500 ohms. An increase in potential to some value, possibly less than one volt, can cause avalanche conditions, to effect breakdown or near zero resistance across the barrier, which indicates the very real possibility of welding in microscopic spots between the bearing surfaces. The spot size and area of roughness developed is dependent on the amount of current flowing. We have measured potentials of approximately 5 millivolts or higher, depending on temperature at the thermal junctions in bearing structures.

We firmly believe that currents generated by thermal junctions within the bearing structure can cause such welding and roughening of bearing surfaces leading to ultimate bearing failure. Such currents can be quite massive, especially after lubrication disappears when currents in the order of 10 to possibly 100 amp can exist.

As to how lightning can cause bearing failure, consider this. Since each

bearing on a normal running car can exhibit some 2500 ohms resistance across its interface, it can be assumed that the car body structure is, for practical consideration, running along, all cars in a train, insulated by the lubricant films from the wheel, rail-earth electrode.

Now assume that a lightning discharge occurs in near proximity to a train, not necessarily a direct hit, the atmosphere around the discharge assumes an electric charge as does any car body within the same partially ionized volume of atmosphere. The charge accumulated on the car body can only dissipate through the bearings and wheels to the rail-earth electrode. And certainly in some instances rather massive current flow must occur at times.

Textbooks on bearing technology state that electric currents of one milliampere or less from potential sources of one volt or less flowing across a bearing interface can cause damage leading to failure.

This might explain why the hotbox incidence is higher in hot summer weather, simply because the lubricant barriers are thinner and therefore are more vulnerable to electrons, from millivolt sources, tunneling through to cause microscopic welding, surface roughening and ultimate failure.

It has been stated that the lubricant film serves to keep the two bearing surfaces from coming into metallic contact with each other. When an electron stream flows from one metallic surface to another through a lubricant film, gas or whatever, the two surfaces are very definitely in bonded metallic contact with each other.

There are many factors that prevent a detector from reading bearing temperatures, but there are two things that are basic and, with present-day technology, inescapable said N&W's Hesser. The first is that a detector cannot scan a bearing. It can only scan the box that houses it. It is most unlikely that the box temperature will be anywhere close to that of the bearing, particularly if the bearing is a solid one. Even though the detector is of a type that scans the arch bar or the wheel hub, it still cannot see the bearing or measure its temperature. Fortunately, there is usually a fairly good relationship between bearing temperature and the temperature of the box, wheel hub, or arch bar. But there is no assurance that this relationship will be uniform from bearing to bearing, or even on the same bearing from time to time.

The second major limitation is that the detector cannot measure temperature even though it might look directly at the bearing. The detector can respond only to radiation. True, if the radiating bodies are alike, and other conditions are equal, the detector can compare temperatures. But we can quickly get into trouble if we assume that all journal boxes radiate equally.

Faced with the realization that hotbox detectors are not go-no-go devices we realize that we must interpret the chart and make an intelligent decision as to its meaning. This is not really a matter of deciding whether the bearing is dangerously hot or not. The real decision is whether or not to stop the train. The decision as to the bearing's condition is entirely in the hands of the train crew, and it is the crew and not the detector that determines whether the car will be set out or taken on.

So, our question is, what basis or what criteria do we use to make the train-stop decision?

It seems logical to establish a maximum permissable chart pen deflection. It may be 16, 18, 20, or maybe 25 mm, but in any event it is an arbitrary figure and must be understood as such. Its choice is the result of past experience and represents a degree of heat beyond which we are not willing to take a chance regardless of comparison with other readings.

Suppose that the maximum allowable deflection is 20 mm. What, then, does a reading of 10 mm. mean? Does it mean that the journal is only half hot? If it is a roller bearing it may mean just this. If it is a solid bearing it may mean that it is quite hot—possibly even dangerously hot. Obviously, then, we cannot rely on any individual deflection as our sole criterion, and we must resort to comparison. Comparison, whether in the form of differentials or ratios, has become accepted as our best guide.

Comparison by the differential method is generally based on reading the two ends of an axle. Comparison of one car in a train with the car next to it is quite proper under some conditions, but far from proper under others. Roller-bearing cars adjacent to solid-bearing cars is a normal occurrence in almost any train. With some detectors, roller bearings produce higher deflections than do solid bearings. Other types of detectors are not so affected and tend to produce reasonably uniform deflections for all bearings operating at normal temperatures. In any event, comparing the two ends of any one axle largely eliminates these variables.

Differential comparison is widely used with automatic alarm devices. The two indications are received simultaneously and can be immediately compared and displayed or discarded. It is, of course, possible for both bearings on an axle to develop trouble and show a zero, or nearly zero, differential. This is certainly not fail-safe, but the possibility of such an occurrence is rather remote.

Sustained sunshine on one side of a train, strong cross winds, or uneven loading of cars may affect differential readings, but these effects are generally not important. Unequal adjustment of the outputs of the scanners on the two sides of the track can produce undesired differential readings, but this is controllable.

A comparison method which I particularly favor is based on ratio. One reason is that it largely eliminates false readings due to one or both scanner outputs being out of adjustment.

The use of any kind of ratio requires that both of the values involved be clearly defined. If we think of the ratio as a fraction we have a numerator that is obvious—the deflection produced by the suspected bearing. The denominator is not obvious. What should it

Hot bearing reading to normal ones ratio is stop criteria

be? It could be the other end of the axle, any other bearing on the same car, any other bearing on the same side of the same car, the lowest reading on the same car, or even some combination of these.

If an automatic device is used, the simplest circuitry would probably be that which would compute the ratio of readings on the two ends of an axle. But this is not wholly satisfactory. We still would have the effects of sunshine, wind, uneven loading, and unequal detector adjustments. These effects might normally be small but under some conditions they could, in combination at least, be considerable. All of these variables can be eliminated if we insist that the denominator of our fraction be taken from bearings on the same side of the train as the questionable bearing.

Assuming now that we have confined our considerations to one side of the train, which bearing, or bearings, are we going to choose as normal? The car under suspicion may have solid bearings and the adjacent one, rollers, or vice versa. This immediately rules out any possibility of comparison of one car with another—at least with some types of detectors.

It now appears that our normal bearing is limited to one or more of the other three bearings on the same side of the same car. It seems logical to assume that all of the bearings on a car would be of the same kind.

On the N&W, we feel that the average of the other three bearings most nearly represents what a normal bearing should read, and is the best basis we can establish in determining the ratio of the heat in a suspected bearing to the heat that that bearing should develop in its normal condition. For several years this ratio has been our principle standard. It does not replace, but is in addition to, maximum deflections and maximum differentials.

I am not under any illusions as to the simplicity of an automatic readout to accomplish the foregoing. We do not have any such device on the N&W. But such a device can be built and I believe already has been built by our friends on the Western Pacific.

If the principle of using the ratio of the deflection of the suspected bearing to the average deflection of the other bearings on the same side of the same car is good, then what is the proper ratio? For years we have used a ratio of three-to-one at all locations. Our mechanical people felt that we should be increasing our yard inspections, so early last year we went to a two-to-one ratio for yard detectors only.

In an effort to hold bearing-failure derailments to an absolute minimum, some two months ago we reduced the ratio to two-to-one for both yard inspection and road stops. Coincident with this change we are considering the advisability of assigning individual standards to each detector. We are not convinced that a standard that is right at one location is necessarily right at another. There is a wide divergence in operating conditions on our railroad. We have mountainous territory where for long distances 50% or more of the mileage is on curves. By contrast we have territory with tangents more than 50 miles in length. We have an entire division with a maximum speed limit of only 35 mph, with much of the division restricted to 25 mph or less. We have other divisions with speed limits of 70 mph. We have hotbox detector spacings under 30 miles in some places and as much as 45 miles in others. We have detectors that were installed primarily to protect bridges and tunnels, and others located for no other reason than to provide good spacing between detectors.

With all of these variables we are looking at our false-stop record at each location to see whether train-stopping specifications for that location should be revised. Other things being equal a system-wide stopping standard is desirable and it is entirely possible that we will wind up with just that. We are well aware of the disadvantage of several recorders in one office being interpreted differently and our present intentions are to avoid this, although with automatic read-out this objection would tend to disappear.

As an example of the value of tying in train-stopping specifications to a location, I might mention that one of our divisions never stops an empty hopper car with roller bearings. They have never had a roller bearing failure on an empty hopper and they feel that years of experience with heavy traffic (25,000,000 car miles per month) justifies this policy. I expect that if they were to get an extremely high heat indication they would stop the train, but they don't get such indications so they don't stop. Loaded hoppers are stopped for inspection when abnormal heat is indicated.

This practice is worthy of note, I think, because it is one that would be difficult to cope with automatically. All recorders on this division are centralized at division headquarters and are read by experienced personnel. All hotbox detectors on the division distinguish between roller and solid bearings. And most empty hoppers are handled in solid trains. This is an ideal combination for high-quality manual readout. To fully automate this would, I am afraid, be difficult.

When we went to the two-to-one ratio, it was with a full realization of what this would do to train stops. There is no denying that it has increased false stops—considerably at some locations, but not too much at others. One value that will come out of this is that we are accumulating a great deal of data that we would not otherwise have had. This data is going to be helpful to us in setting our standards for the future.

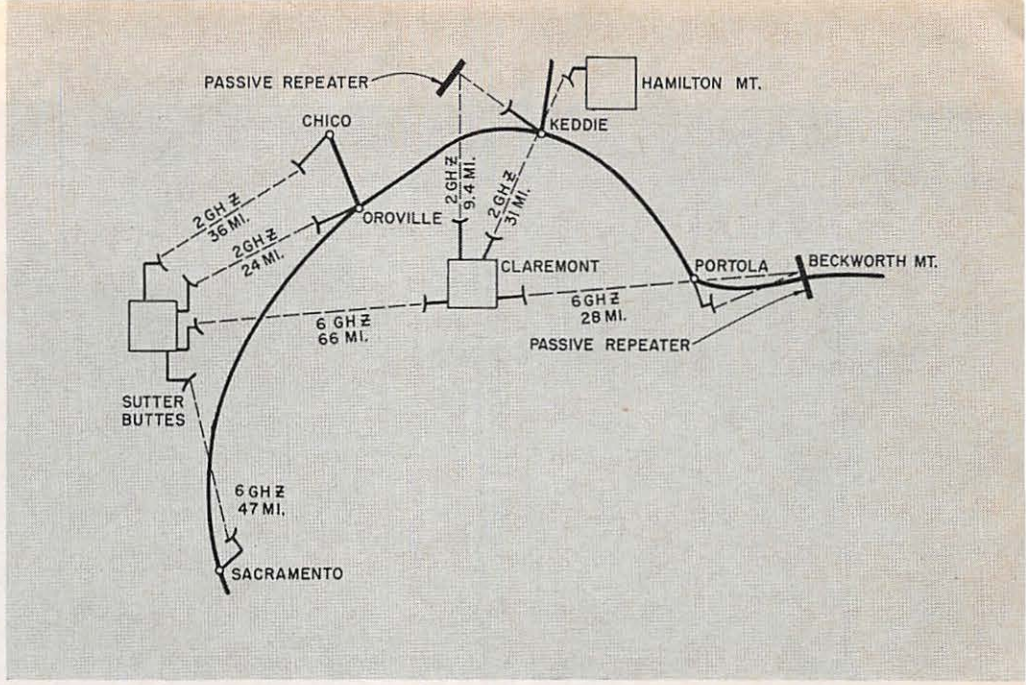
Our current standards are: (a) A deflection of 16 mm or more; (b) A differential of 6 mm or more between bearings on the same axle; (c) A ratio of two-to-one or more between the highest reading and the average of the other readings on the same side of the same car. A train is stopped for inspection if any one or any combination of these is observed.

There is another item that concerns me, and that is the large number of roller-bearing set-offs compared to the number of actual overheated rollers. During one recent month this ratio

went as high as 7:1 on our road. Unquestionably some of this is due to tightening up our stopping specifications. But we see other reasons too. For instance, the lid of a solid-bearing box can be lifted and the condition of the journal, pad, and lubricant can be pretty well determined by visual inspection. When a roller bearing is inspected the crew can usually tell nothing about the bearing other than to estimate the temperature by feeling it. During the time that the train has been stopped the box has been cooling. The amount of cooling is not known, and so there is no way of telling how hot the box was when it passed the detector. Knowing the possible seriousness of a roller-bearing break-up, and not knowing the condition of the bearing, the crew will probably elect to take the safe course and set the car out.

I believe that one of the major causes of roller-bearing set-offs on the N&W is over-lubrication—not just because of what it does to the inside of the box, but because of what happens on the outside of it. Determining the amount of grease needed by a roller bearing is not easy. As a result grease may be added in fixed quantities which are sometimes not quite enough and sometimes are too much. The excess grease normally is discharged from the vent fitting, but occasionally also leaks out around the seal. The result is a mixture of grease and dirt on the outside of the box which apparently increases radiation from the box. The increased radiation is interpreted by the hotbox detector as an abnormally warm bearing and the train is stopped. Some of the bearings involved in these stops have been disassembled, and in no instance have we found any reason to believe that the bearing would run any hotter than any other bearing.

The box temperature may actually be higher because of the presence of too much or too little grease inside the box. Too little grease obviously could result in insufficient lubrication. Maybe too much grease actually adds to friction loss. When the manufacturer's specifications are followed, only about 50% of the cavities in the bearing are filled. When over-greased, rotation of the bearing forces grease through very restricted spaces. It seems reasonable to believe that this requires additional work which could in turn produce additional heat.



Western Pacific microwave extends from Sacramento east to Portola.

Microwave gives WP data links

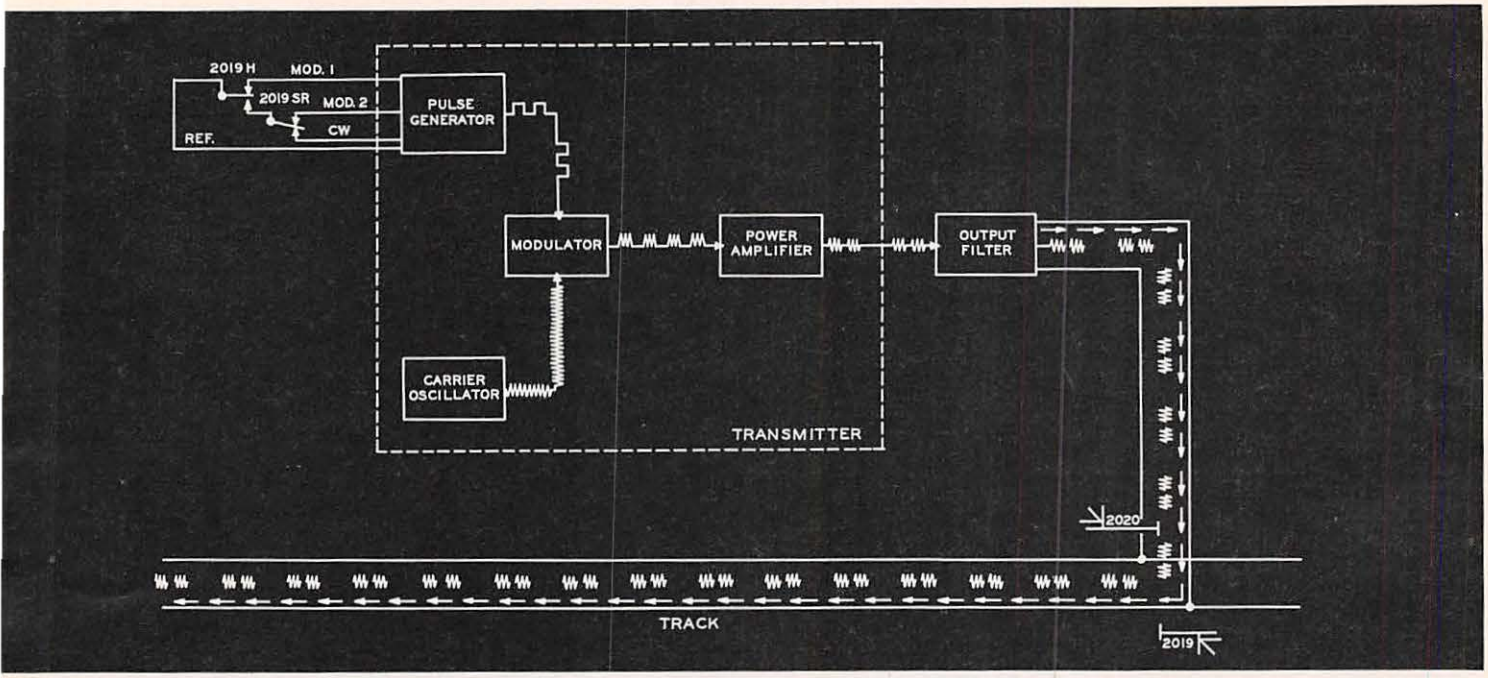
In September, Western Pacific turned on its first microwave system operating between Sacramento and Portola, Cal. The system will carry initially 24 voice channels to the various terminals, as well as the dispatchers' telephone circuits and all signal code circuits controlling trains between Pulga and Salt Lake City. The signal circuits will ride on the microwave system from Sacramento to Portola where they will return to the insulated wire code line.

Robert E. Enger, superintendent of communications, who designed the system and selected the microwave paths and equipment, describes the routes. "From Sacramento transmission is beamed from a 120-ft tower to Sutter Buttes, 47 miles, and space diversity is used on this path. From the repeater at Sutter Buttes, the microwave signal is sent over a 66.5-mile path to Claremont (a mountain top). Transmission received at Claremont is then retransmitted to Portola and Keddie by billboard-type reflectors because these two stations are located in valleys surrounded by mountain peaks which obstruct microwave signals. A 24 x 30 ft reflector on Beckwourth mountain, 28 miles from Claremont, reflects the microwave signal 2.8 miles to Portola. The Keddie microwave signal is reflected by a 14 x 16 ft reflector on the mountain side 9.4 miles from Claremont but only one-half mile from the Keddie depot. Oroville and Chico are line-of-sight paths from Sutter Buttes," Enger said.

The backbone system, operating in the 6GHz frequency range, is Lenkurt Electric 78B1 equipment, which runs from Sacramento via Sutter Buttes and Claremont to Portola. Other sections of the microwave system operate at 2GHz and are equipped with Lenkurt Electric type 71F2 microwave. To improve reliability, standby units are provided with automatic switch-over should the normal sets fail.

VHF radio stations at Sutter Buttes, Claremont and near Jarbo Gap provide train to wayside communications under the control of train dispatchers at Sacramento.

Repeater is at Claremont.



PULSE MODULATED CONTROL TRANSMITTER block diagram shows major subassembly units.

Electrified lines can use PMC

With increased interest in electrification, there is concern with the cost of modifying or changing existing DC track circuits, which at present are not compatible with electric traction systems using running rails for propulsion current return. An approach to the problem was presented by C. M. Hursh, former system application engineer, Marquardt Industrial Products Co., to the Committee on Electrical Facilities-Fixed Property, AAR. October 21, 1969. An abstract of his paper follows:

Signaling on American railroads predated any consideration of electrification in the past, present or future. The design criteria for our signal systems, in non-electrified territory, did not strive for any degree of compatability with electric traction systems such as using the running rails for the propulsion return path.

Signal engineers and designers have long recognized the interference problems created by underground haulage systems, paralleling transmission lines, street railways and cathodic protection on underground pipe lines. These problems were dealt with by the application of special circuits in problem areas. Otherwise, the generally accepted method of train detection was the steady energy DC track circuit and in later years, coded DC track circuits. For a brief period, AC steady energy track circuits were adopted on some railroads. This type of signaling lost popularity with the availability of power from commercial sources and improvements in DC circuits. Consequently, very few of the AC signaling systems remain in service today.

The vital safety portion is still vested in the signal system principle in which the running rails form the basic foundation. It is inconceivable that any radical departure will be made any time soon from this principle except for highly specialized applications such as: rapid transit lines and private haulage systems for the following reasons:

(1) Properly designed and installed track circuits provide broken rail protection. Existing Federal regulations stipulate that such protection must be inherent in all signal systems. This feature assumes even greater importance in welded rail territory.

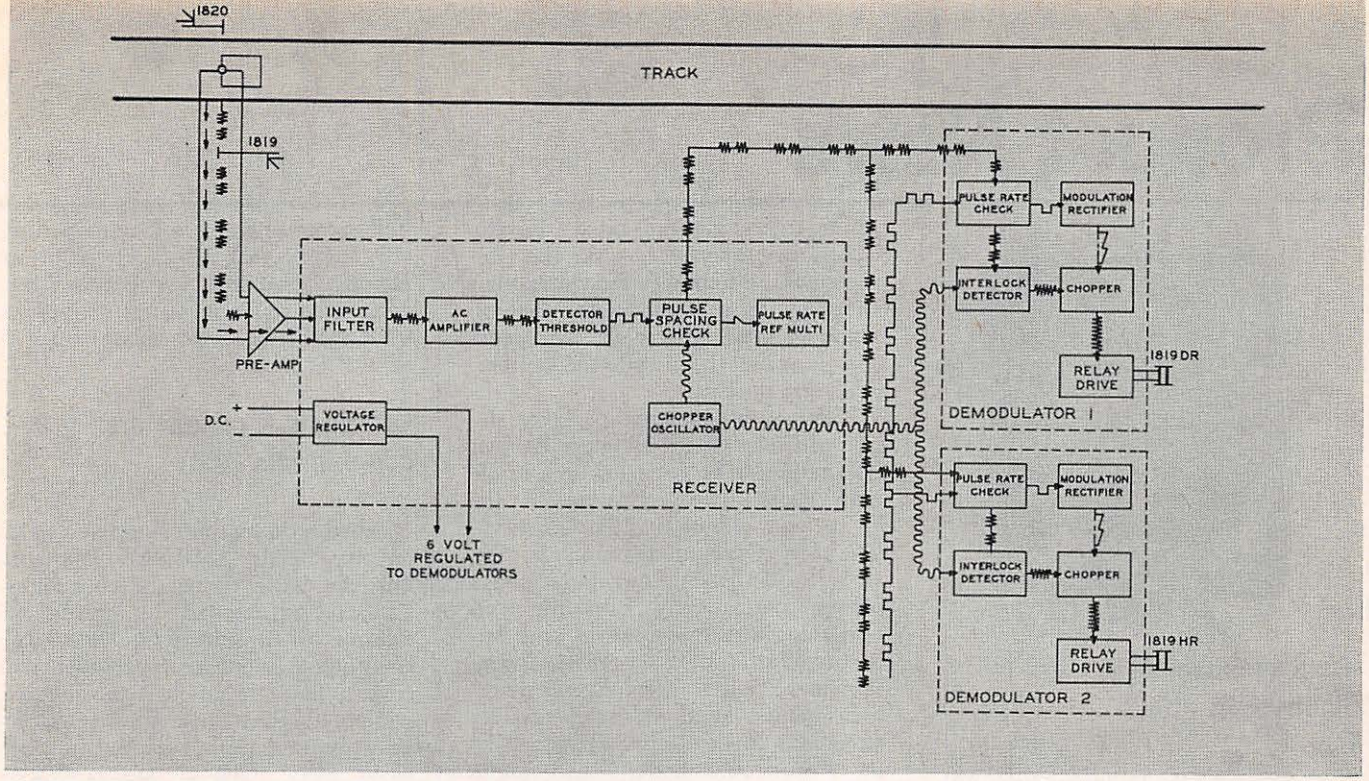
(2) The rails provide a convenient path for vital data flow between adjacent signals. This is a marked improvement over earlier systems that depended upon open wire pole lines or cables to supplement the track circuits. It is a matter of record that a majority of the signal failures result from open, shorted or grounded line wires or cable. Furthermore, the increased cost of labor to maintain open line construction has placed a financial burden on many railroads.

(3) Where line circuits are retained in electrified territory, protection must be incorporated to guard against interference created by transients from trolley and transmission lines.

(4) The use of track circuits eliminates any requirement for equipment mounted on the locomotives, except in train control and/or cab signal territory. This is particularly advantageous where motive power is interchanged between railroads.

To define the limits of conventional AC or DC track circuits, coded or non-coded, it is necessary to physically isolate the rails; thereby introducing the insulated rail joint. This fixture was never popular with track engineers as it represented the weakest point in the entire track structure. Over the years, insulated joint failures have increased due to inadequate maintenance and more recently with the introduction of welded rail.

In order to make use of the rails for traction power return, signal engineers were faced with the installation of special track circuits that would be immune to the effects of propulsion power. These were usually AC track circuits of some non-commercial frequency. The use of non-commercial frequencies introduced the need for conversion equipment usually in the form of motor generators plus distribution lines to energize the individual track circuits. These track circuits still depended upon insulated joints which further complicates the problem by requiring impedance bonds around each set of joints in order to maintain a low impedance path to the substation. Due to the highly specialized nature of this



PULSE MODULATED CONTROL RECEIVER block diagram shows major units including demodulators.

signaling

equipment and low demand, costs are proportionately higher and lead times longer on delivery. When all the above factors were taken into consideration, the railroad was faced with a very costly signal system to install and maintain in order to electrify.

The PMC system has been designed using failsafe circuit principles. Failure of components, by either shorting or opening, or failure of a complete stage of circuitry, will not result in a falsely energized relay. This practice has been carefully carried out in the design of transistor circuits in the entire system. Multiple fouling and broken rail protection features of the PMC have been proven in actual practice on various railroad installations. Closed circuit principles are used through-out the system to ensure failsafety. PMC equipment is designed to interface with all conventional signal systems. It may be used to supplement existing installations such as to achieve compatability for electrification or as the basic detection and data-flow system for new signal projects. The equipment uses 100% solid-state components mounted on printed circuit boards which are plug-coupled for ease in testing and maintenance. PMC electronic circuits are fully temperature-compensated and no special protection is necessary, even in the most extreme ranges of temperature or humidity.

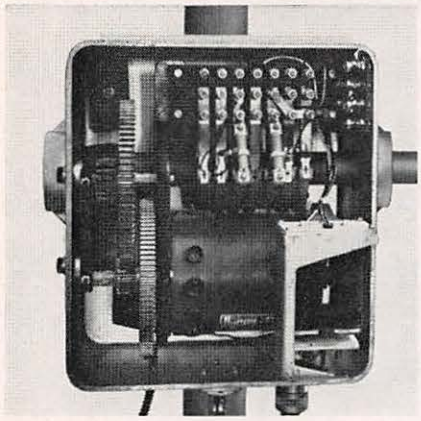
PMC is equally adaptable in non-electrified territory as well and has been successfully installed on about 180 miles of mainline in the east, midwest and western regions of the U.S. that is not electrified. This standardization results in reduced manufacturing costs and immediate availability which is a decided advantage over the former systems requiring much specialized equipment. In addition to the several successful installations on the Long Island, PMC has also been installed in 25 Hz territory on the Penn Central for block signal control. Performance in each instance has been entirely satisfactory. Total installations on electrified territory total approximately 46 miles.

The original block signals were spaced "braking distance" apart for maximum track capacity. Surprisingly, many of the original signal locations remain today except with modern light units replacing semaphore mechanisms and obsolete relays. Except in several metropolitan areas with high density commuter traffic, maximum track capacity is no longer important. However, the introduction of longer freight trains operating at greatly increased speeds has brought about the need for revamping signal systems to achieve adequate braking distance. Some railroads have corrected this problem by respacing the signals which results in the complete elimination of many locations. On other railroads, this problem was resolved by adding additional aspects in order to convey information sufficiently far in advance to the engineman so that train speed could be reduced to avoid rear end collisions. These additional aspects require more data-flow channels which again adds to the cost of the system. In considering electrification, each railroad should closely analyze their signal spacing in order ro realign their system with present day requirements. This would hold true regardless of the type of signaling being considered.

Audio frequencies could replace the conventional track circuit entirely. This development came to light when sufficent interest was again directed toward electrification. Approximately three years ago, Marquardt Industrial Products Company in cooperation with the Long Island Rail Road developed an entirely new concept of electronic track circuit that overcomes many of the aforementioned problems; while at the same time, effecting significant cost reductions. PMC for pulse modulated control meets or exceeds all failsafe requirements of state and federal regulatory agencies having jurisdiction over railway signaling. It is equally adaptable to DC or AC traction systems regardless of propulsion frequency used.

The Pulse Modulated Control (PMC) is an automatic wayside block signal system which transmits coded information through the rails, using audio frequency as a carrier. This technique permits signaling without line wires or insulated joints. Coded pulses, consisting of precisely timed and spaced bursts of audio frequency currents, are transmitted between signal locations. Ten code combinations and eleven carrier frequencies are available to handle a wide variety of complex signal installations. The transmitted information is picked up by receiving equipment which responds only to signals having the proper frequency and code. Each code channel, when activated, supplies a DC voltage output, which may be used to operate signal relays.

Product News



Gate mechanism is lightweight (101)

A lightweight, aluminum highway crossing gate mechanism and signal assembly has signs and crossarms fastened to the mast with stainless steel bands. The gate mechanism is over 240 lb lighter than previous models. The gate arm is of sectional, pre-fabricated wood construction for speedy installation or replacement.

Type F gate is provided as a complete signal assembly, with aluminum mast, flashing lights etc.; or as a mechanism and gate arm only, with an adaptor for mounting on any existing 4" or 5" mast. The aluminum signal assembly is also available as a flashing light signal, without the mechanism and gate arm. *General Railway Signal Co.*

Control unit monitors CPU environment (102)

Dependable operations of computers and associated EDP peripheral devices rely on a closely maintained temperature and humidity environment. The user can set the desired environmental limits into EnviroGuard by simply sliding front panel set points to the desired range. EnviroGuard continuously monitors the temperature and humidity for fluctuations violating these "set point" values, sounding a warning when one occurs and permanently records the temperature and humidity.

The unique automatic trigger design of EnviroGuard allows months of information to be recorded on a single strip chart. The activation of the "auto reset" button places EnviroGuard in a fully automatic mode. Any violation of the set point starts the recorder, permanently recording and displaying the temperature and humidity of the EDP installation's environment. When these parameters return to in range values, recording stops and EnviroGuard returns to its monitoring only mode. When not in the automatic mode data is continuously recorded for long term full view presentations of the environment and violations of the set points are indicated by a visual and audio alarm. *Western Union Computer Utilities, Inc.*

Leak detector designed for cable systems (103)

Model EI-100 leak detector is specially designed for location of ultrasonic energy leaks in pressure cable systems, microwave antenna systems, etc. The EI-100 detects emission of ultrasonic noise in the frequency range of 34-45 KHz. A filtered transducer pickup in the EI-100 probe functions in this exact bandwidth.

No special training is required; the operator merely connects the headset to the detector probe, switches on the unit and follows the ultrasonic "sound" to the exact location of the leak.

Power supply is a self-contained, 9-volt battery with life in excess of six months, based on 8-hour-per-day duty cycle. The probe measures 1¼" dia. x 9" long. Probe and headset weigh 8 oz. *E.F.I., Inc.*

Terminals & connectors come in kits (104)

Based on a computer study of maintenance needs AMP-PAK kits contain the basic terminals, connectors, and tooling needed for electrical/electronic applications. The basic computer-selected items included will cover most situations encountered without duplication and waste. However, the kits are not limited to these basic items. Each kit has provisions for several options which can be selected from over 30,000 wiring devices.

Replacement/supplementary items are supplied in sealed packages with twin adhesive-backed labels which describe and picture the product in color. These labels can be attached to the kit lid sheet for ready identification and simplified inventory. *American Pamcor Inc.*

New catalog lists wire and cable products (105)

A new, concise catalog lists a full line of wire and cable, tubing and sleeving, and microwave dielectric products. Also included are mechanical and electrical characteristics, and application descriptions. *Brand-Rex Division, American Enka Corp.*

Conversion units for signals available (106)

The IW 10 conversion units are the operating optical units of the Raco Unilens signal so designed as to replace the relay operating unit of all current types of searchlight signals. The conversion unit will utilize the existing searchlight signal housing. After removal of the existing relay mechanism assembly the IW 10 conversion unit is placed into the housing utilizing existing mounting hangers or brackets and lens assembly. In some cases the lens system may require alteration.

Model IW 10-H conversion unit is designed to replace the type H searchlight mechanism and is of the stepped

(Please turn to page 33)

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Know-how creates: *simplified speed change.* The flexibility of our design of the 75-baud unit allows the basic modem to be adapted to 110 baud by a simple change of the filters. Changing from 75 or 110 to 150 baud necessitates only the change of the filters and the receiver assembly.

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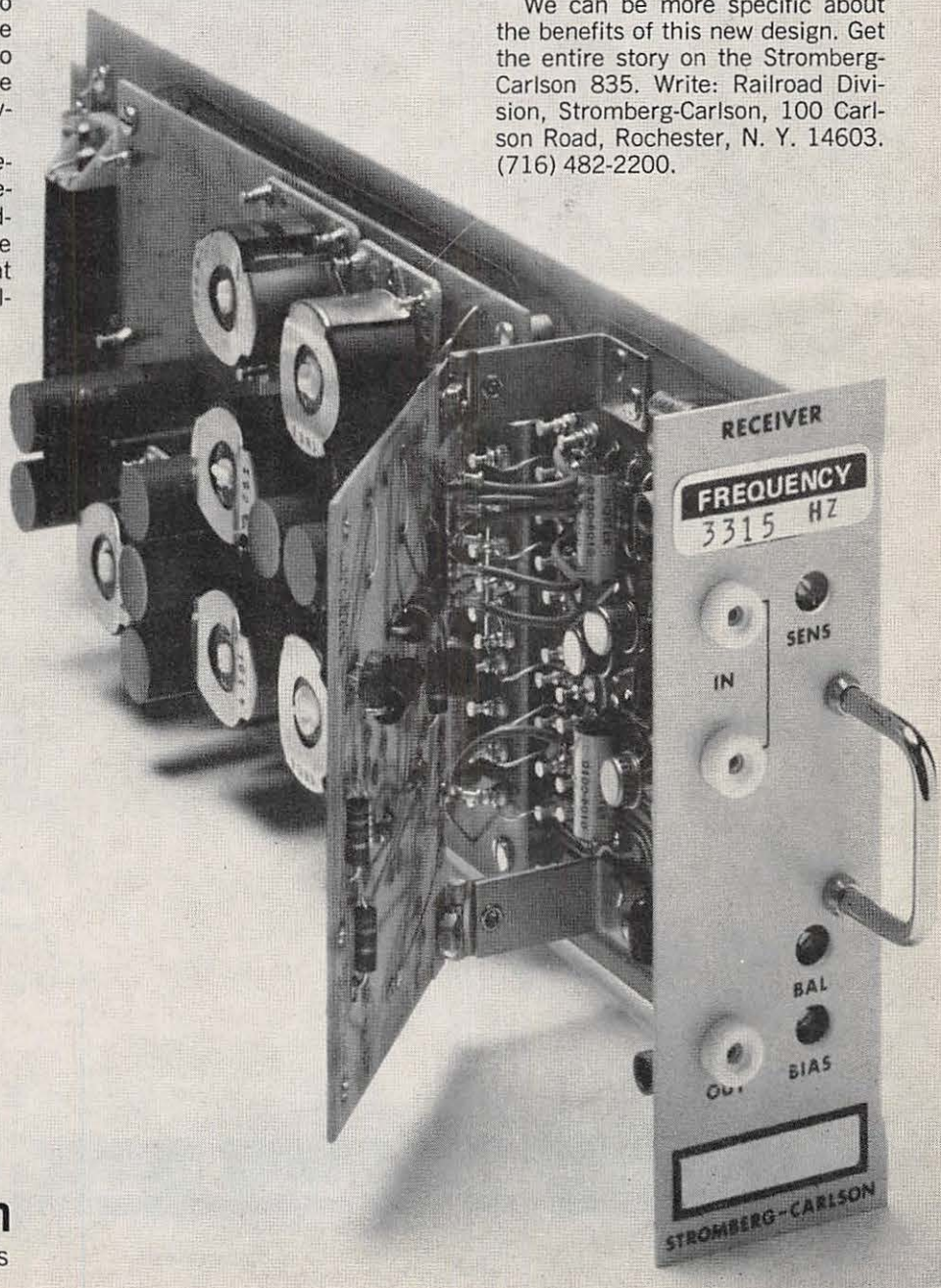

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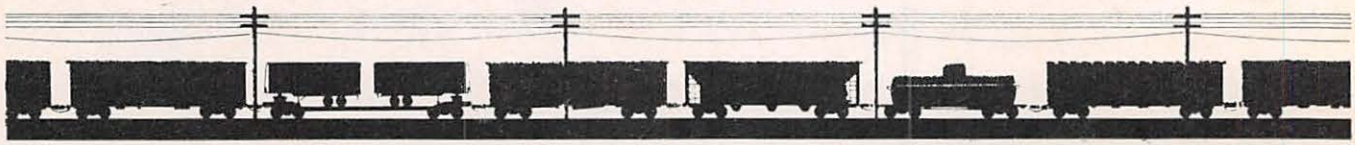

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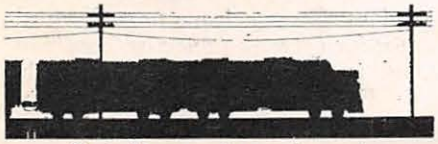


Circle 14 on reader service card

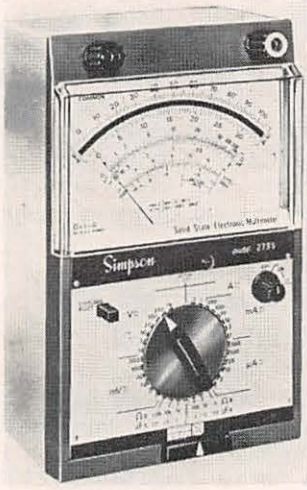
PRODUCT NEWS

(Continued from page 30)

lens type. In this case the outer stepped lens is furnished and will replace the existing outer lens. An adapter ring and spread or deflecting lens, as required, are available for beam characteristics. May be converted to a compound lens type.

Model IW 10-H2 conversion unit is designed to replace the type H2 searchlight mechanism and is of the compound lens type. The outer lens of the existing H2 assembly is utilized without change or alteration.

Model IW 10-SA conversion unit is designed to replace the type SA searchlight mechanism and is of the stepped lens type. The outer stepped lens is furnished and will replace the existing outer lens. An adapter ring and spread or deflecting lens, as required, are available for beam characteristics. May be converted to compound lens type. *Railroad Accessories Corp.*



Multimeter has 68 function capacity (107)

A new solid-state electronic multimeter, model 2795, has 68 switch-selectable functions for measuring 13 AC and DC voltage ranges as low as 1 mv full scale, 14 AC and DC current ranges as low as 1 ua full scale, 6 low power (1C compatible) resistance ranges (.9 mw dissipation), 6 completely self-contained capacitance ranges from 1 uf to 100 uf, 2 temperature ranges, plus 12 output ranges (dB). Temperature compensated over a range of 0° to 50°C, rated accuracy is ±1.0% for both AC and DC.

Completely battery operated, the new model 2795 has a self-contained transistor amplifier and Mos-Fet chopper. It features 10 megohm input impedance on AC and DC ranges above 10 volts and negligible voltage drop (7 mv at 10 ua). The amplifier is very stable, eliminating the need for zero adjustments on voltage and current ranges. The built-in electronic chopper provides the AC needed for capacitance measurements; no external power. *Simpson Electric Co.*

Cable cutter has wire stripper too (108)

A BX and cable cutter (No. 1104) has high leverage which enables it to cut through BX and cable easily. A stripping notch is incorporated in the design. Length is 7" with length of cut 1⅛". Handles are red, plastic coated. *Mathias Klein & Sons, Inc.*

Inband signaling has solid-state units (109)

Inband signaling system 650, described in a brochure, permits economical use in low density systems with master and standby oscillators combined with additional equipment to provide a high density system powering up to 300 signaling units. The system application has the basic function of converting various types of E&M Loop, DC or 20 Hz signaling and supervisory information into 2600 Hz inband, SF tone for transmission over any voice facility.

Features of this 650 inband signaling system are that the solid state design allows over 200 signaling units, has voltage regulation on the input battery between −21 and −55 volts DC, transmits and receives pulse correction on signaling units to meet and exceed industry requirements, provides only one adjustment to reduce alignment and maintenance time, uses universal wiring with interchangeability of signaling units, and has rack arrangements in 19" or 23" shelf configurations. *Wescom Inc.*

News Briefs

DT&I speeds data to computer via FAX

Waybill, freight bill, car movement and interchange information is promptly being transmitted from key yards on the Detroit, Toledo & Ironton to the road's computer center in Dearborn, Mich., via a combination of facsimile and IBM 1050 data transmission. At the north end of the railroad, Flat Rock yard is a concentrator point for surrounding yards at Diann, Delta, Ford and Rouge. Data is sent via Magnavox model 850 facsimile units from these yards to Flat Rock, where the information is keypunched into cards for transmission via a 1050 unit to Dearborn. Transmission time is about 6 minutes over a telephone circuit for an 8½ x 11 inch document.

At the southern end of the DT&I, Graphic Sciences Corp. facsimile units are located in yards at Waverly, Jackson and Washington Court House for sending to a similar unit at Springfield, Ohio. Here data is keypunched for transmission to the computer at Dearborn.

Santa Fe orders 9 ACI systems for KC yard

Santa Fe has awarded a contract to Sylvania's Commercial Electronics division for nine KarTrak automatic car identification systems. These nine plus two systems now on test at Winslow, Ariz., and Clovis, N.M. will be installed at Argentine yard near Kansas City. The ACI units will be equipped with the AAR standard interface (see page 14).

Telpak sharing order stayed up to 90 days

Federal Communications Commission has voted to stay its Telpak sharing order not to exceed 90 days from Aug. 17 or until it decides what to do about the petition for reconsideration it has received.

The AAR, according to *Telecommunications Reports*, said that "The elimination of sharing alone would more than double the communications costs of railroad customers who actually now share Telpak C and D. The elimination of Telpak would increase the communications costs of the Penn Central Co. by at least five times."

Referring to the decision's statements about private microwave competitive alternatives, AAR said that neither the railroad witness in the Telpak sharing case "nor any other sharing-eligible Telpak user witness was asked for an evaluation of the importance of rights-of-way, the amount of communications requirements specified on the basis of cost alone or the amount of presently shared Telpak usage for which no feasible private microwave exists . . . If such facts are really necessary to a decision and if the role of the Common Carrier Bureau is, as claimed, to insure that all pertinent facts are developed in a record such as this, a remand of the proceeding is necessary at the very least."

Oregon Technical gets license for HB detector

Railtron Corp., Richmond, Va., has consumated an exclusive license agreement with Oregon Technical Products, Belmont, Calif., for the manufacture and marketing of its hotbox detector. Also included in the agreement are a wheelmark jet, indicator array and dragging equipment detector.

Stewart-Warner gets BART info contract

A $5 million computerized passenger information system has been developed by Stewart-Warner Electronics for San Francisco's BART automated rapid transit system. Double-faced signs (276) will be installed at 33 BART stations and will be linked to a computer in Oakland. Information generated at Oakland will be sent to each station which will have a processor, with a 4,000 word memory to control the signs. The central information system processor will be tied in with the transportation control computers so as to receive current train running information.

S-W is discussing its system with MTA in New York and with WMATA in Washington, D.C. for possible application to their transit systems.

ACI Systems Corp. formed to sell ACI equipment

A new firm has been organized to market automatic transportation equipment identification scanners and ACI label-decoding processors. Known as ACI Systems Corp., the firm is headed by W. H. Thompson as president, who was formerly vice-president operations and general manager, Illinois Central. General marketing manager is James Anderson, also manager transportation control systems, Computer Identics.

ACI Systems Corp. is part of the Diebold Group associated with Intermodal Transportation Systems, Inc., and Computer Identics Corp. Chairman of ACI Systems is Palmer Bayer, ITS president, and David J. Collins, CI president is chairman of the executive committee of ACI Systems.

One of ACI Systems first projects is implementation of ACI at Illinois Central's intermodal terminal in Chicago. Three ACI-based road scanners are being installed to identify labels on trailers, containers and tractors.

Interconnection units should be certified

Interconnection of customer-owned facilities with the public telephone network received further attention recently from the Federal Communications Commission, communications common carriers and customers. It started with a National Academy of Sciences report which called for protective arrangements required by the tariffs and a properly authorized and enforced certification program to provide the necessary protection to the telephone network.

American Telephone & Telegraph Co., according to *Telecommunications Reports*, told the FCC that it "believes, as the panel concluded, that the present tariff regulations are a proper approach to the question of protection. If the panel's proposed enforced certification program can be implemented successfully in all of its phases, and its costs fairly allocated, it could serve as a supplementary procedure for assuring the necessary protection."

Customer-provided equipment should be permitted to interconnect directly to the public common carrier telephone network without the necessity of common carrier-provided interconnecting arrangements, "as long as such equipment meets common carrier-developed and Federal Communications Commission-approved standards for network protective capability and is installed and maintained by an FCC certified installation/maintenance organization or individual

contractor," a consulting firm (Dittberner Associates) has recommended to the FCC.

The Dittberner report also stated: "Existing common carrier tariff provision requiring common carrier-owned, installed, and maintained network protection and network control signaling devices, as well as other spectrum energy distrubution standards, are sufficient to protect the network, its personnel and customers from harm which could result from inadequately designed or malfunctioning user-provided equipment.

"Common carriers should not have an exclusive right to provide equipment with network protective capabilities to the end-user."

Other recommendations in the report included: "The FCC should direct existing common carriers to remove all tariff provisions which require the use of common carrier-owned network protection and common carrier-owned network control signaling devices.

"The FCC should direct all common carriers to include in their tariffs provision requiring: notification by customer of his intent to attach non-common carrier equipment to the network; common carrier approval of the customer-owned interconnected equipment in accordance with FCC-approved network protective capability criteria, prior to interconnection."

In commenting on the NAS report, Southern Pacific Communications Co. agreed generally and backed a certification and standards program. This, it said, "would allow certification of the fact that a device proposed to be connected to the telephone network did in fact contain . . . an isolating device which would insure that the telephone network would not be exposed to harmful voltages, wave forms, or frequencies. If the device did not contain such an isolation device, it could still be certified for connection, provided it were isolated from the network by an appropriate connecting arrangement, whether provided by the carrier or the customer."

The AAR noted that the panel report apparently suggests that "all right-of-way companies such as the railroads would require certification of all equipment now interconnected." Instead, AAR declared, those which have been interconnected for years should have "grandfather" rights. It also backed certification by manufacturers, declaring that "too little weight has been given to the historic relationship between the common carriers, the right-or-way users, and the supply industry."

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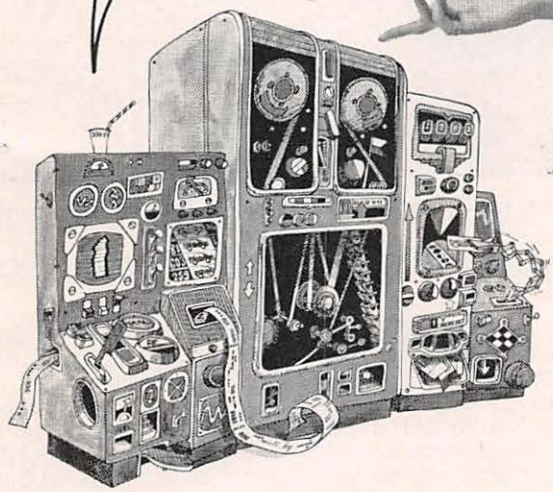

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(Act of October 23, 1962; Section 4369, Title 39, United States Code)

1. Date of filing Sept. 29, 1970.

2. Title of publication Railway System Controls.

3. Frequency of issue is Monthly.

4. Location of known office of publication: 508 Birch St., Bristol, Conn. 06010

5. Location of the headquarters or general business offices of the publishers: 350 Broadway, New York, N.Y. 10013

6. Names and addresses of the publisher, editor, and managing editor:
Publisher, Robert G. Lewis, 350 Broadway, New York, N.Y. 10013. Editor, Robert W. McKnight, 29 E. Madison St., Chicago, Ill. 60602. Managing editor, none.

7. The owner is:
Simmons-Boardman Publishing Corporation, 350 Broadway, New York, N.Y. 10013—Stockholders of one percent or more are: Arthur J. McGinnis, 350 Broadway, New York, N.Y. 10013; Morton & Co., P.O. Box 2400, Church Street Station, New York, N.Y.; Joseph or Katherine Sanders, 6010 Prestonshire, Dallas, Texas 75225; Bache & Co. Incorporated, 36 Wall Street, New York, N.Y. 10005; Merrill Lynch, Pierce, Fenner & Smith, Inc., 70 Pine Street, New York, N.Y. 10005; J. W. Gould & Co., 120 Broadway, New York, N.Y. 10005.

8. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None

9. Not applicable.

10. Extent and nature of circulation.

A. Total no. copies printed (Net Press Run) Average is 4,111, Single issue nearest filing date is 4,275.

B. Paid Circulation

1. Sales through dealers and carriers, street vendors and counter sales. Average 0; Single issue nearest filing date 0.

2. Mail subscriptions. Average is 2,994; Single issue nearest filing date is 2,818.

C. Total Paid Circulation. Average is 2,994; Single issue nearest filing date is 2,818.

D. Free Distribution (including samples) by mail, carrier or other means. Average is 953; Single issue nearest filing date is 1,314.

E. Total Distribution. Average is 3,947; Single issue nearest fiing date is 4,132.

F. Office use, left-over, unaccounted, spoiled after printing. Average is 164; Singe issue nearest fiing date is 143.

G. Total. Average is 4,111; Single issue nearest filing date is 4,275.

I certify that the statements made by me above are correct and complete.

(Signed) Robert G. Lewis
Publisher

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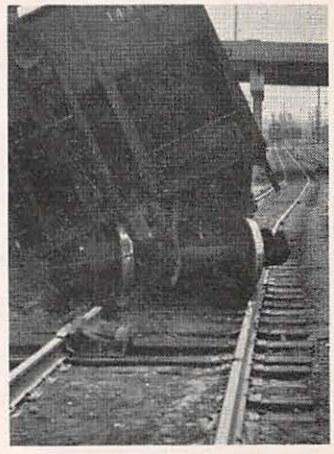

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Circle 15 on reader service card

Editor's Corner

Do you get the most out of the data you have?

It has been said that with computers, there is probably more information available today than ever before in the history of mankind. And by the looks of some desks or tables where computer printouts are stored, the "stack feet" i.e., vertical height of paper printout, indicates that the foregoing would seem to be true.

Is this mass of data or information available to the people who can use it? Are users and potential users made aware that such data exists?

Automatic car identification is a case in point. Many railroads are considering using ACI, but as yet very few know what to do with the output, especially beyond the obvious of checking upon the accuracy of existing methods of obtaining car identification.

MANY USES OF ACI DATA

Illinois Central, for example, has found at least two other uses of ACI-generated data from its St. Charles Air Line installation. Originally installed to identify trains and count cars moving through this joint facility, IC now finds that the ACI scans of inbound IC trains from its western line from Iowa can provide inbound train checks for Markham classification yard. Also, the St. Charles ACI can be used to provide advance consists for IC transfer moves to other railroads. At least one connecting line has asked for such information.

Another area of using existing information is that of making connecting train schedules. Efforts are continually made by railroads to reduce over-the-road time using such proven methods as installing centralized traffic control and using high horsepower locomotives to provide high sustained speeds over lines with heavy grades and curves. But, how many railroads are analyzing their connection times to determine if all this over-the-road speed is necessary? Would slower schedules with resultant savings in fuel still enable trains to arrive at terminals in time to make connections?

The General Managers' Association of Chicago ACI task force in making its study for terminal controls based on an ACI-computer complex made extensive use of yardmasters' records, dispatchers' train sheets and interlocking operators' records of moves through plants. Interestingly—and probably not really startling—most transfer moves in the Chicago terminal take place during late afternoon and early evening hours. This is fine to enable late pulls from industries and make outbound connections, but it certainly makes for congestion.

An examination of outbound connection times might reveal that if transfer moves were staggered, congestion could be somewhat relieved. For example, to make an 11 pm or midnight connection, would it not be better to have some transfer moves leave yards at 7 or 8 pm, rather than all move in the 6-7 pm time period? Admittedly, per diem cut off times are a factor, but it might be worth the effort to re-examine transfer move policies.

If transfer moves could be speeded up in the terminal, maybe piggyback trailers could be more efficiently moved via flat car rather than via highway. Yes, I've been told that some railroads in the Chicago area take trailers arriving from the west and unload them from flat cars to be driven over highways to an eastern line ramp, where they are reloaded on flat cars for further rail movement. And it also works in reverse. Here again, data on connecting trains is now available. It just has to be used.

True, there are some run-through moves of entire trains or blocks of cars, but terminal congestion might be considerably reduced by planning and making use of existing information.

COMPUTERS NOT FOR ALL

Not everything in railroading can be automated or should be computerized just for the sake of "being modern", but it would appear that there is a communications gap between data processing and users of data.

The Data Systems Division, AAR, has produced a digest of analytical techniques available from various railroads. Could a similar digest be developed on individual railroads? For example, the data processing or management services department could periodically issue (via computer printout) a digest of reports and information (in categories) available. Such a digest should be available and useful to most any supervisor or manager, say from division engineer or superintendent right up to the president.

Data and/or information is available in large volume on the railroads. It should be fully used—and that requires communication.

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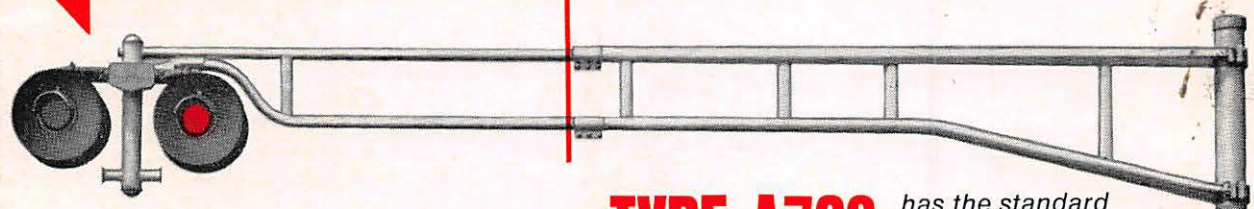
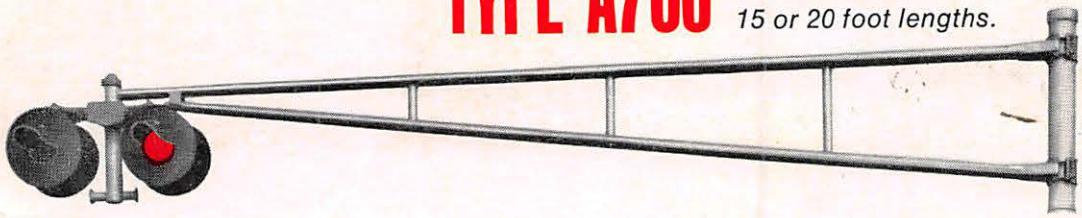
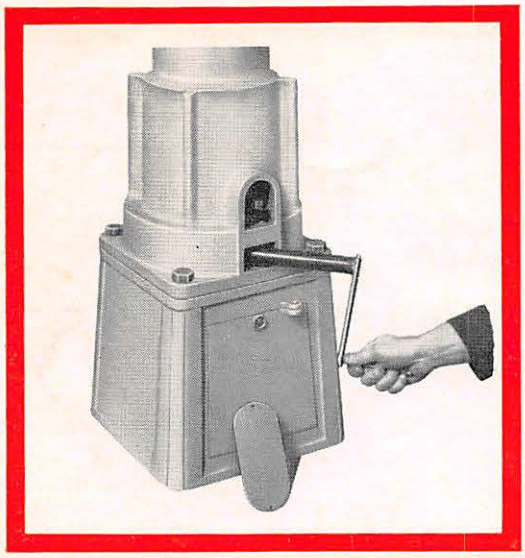


TYPE A760 *has the standard bracket arm in 12, 15 or 20 foot lengths.*





As you know, the standard bracket arm with the Western-Cullen Type A760 Cantilever generally suits most requirements precisely "to a T." No question.

The *telescopic* bracket arm with our Type A770 Cantilever, however, is specifically designed to provide adaptability for crossings that require intermediate lengths of arms—anywhere between 15 and 20 feet. Telescopic arms are ideal, furthermore, for use at crossings where there is likelihood of future widening of the highway.

Other than that, both types of Western-Cullen Cantilevers have the same basic features to assure overall enduring performance.

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